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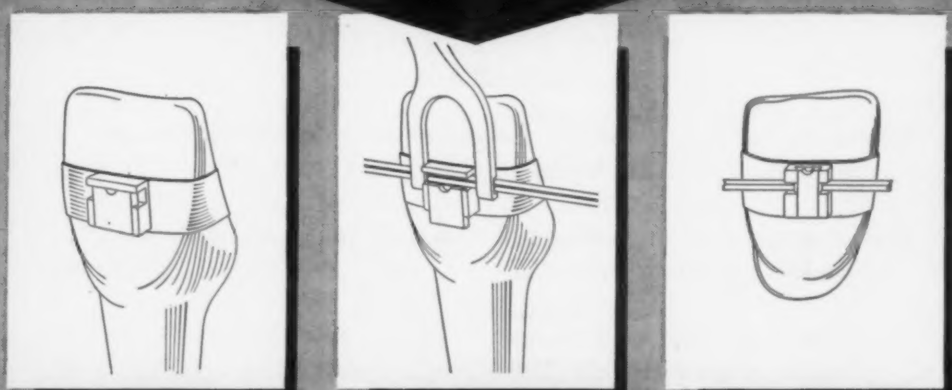

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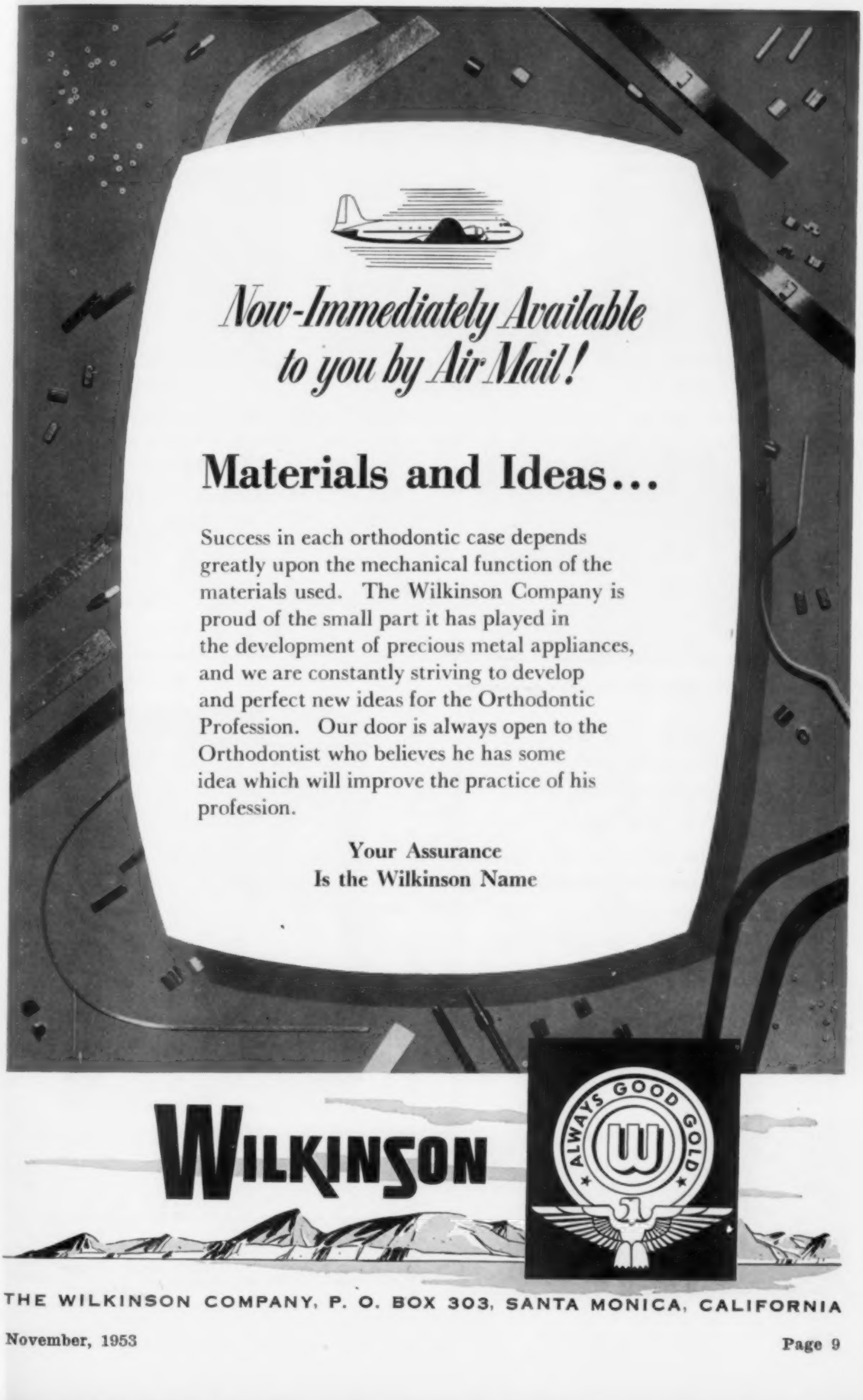
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American Journal
of
ORTHODONTICS

VOL. 39 NOVEMBER, 1953 No. 11

Original Articles

PRESIDENT'S ADDRESS, AMERICAN ASSOCIATION OF ORTHODONTISTS

BROOKS BELL, D.D.S., DALLAS, TEXAS

When I was installed as your president in St. Louis, I took office with the idea that our Association was operated by a small group of our members and that this operation mainly consisted of the annual session. It did not take long for me to discover that this idea was entirely erroneous.

Our American Association of Orthodontists is in operation the year round through the combined efforts of your officers, your committeemen, and the many, many other members who are called in to do special work.

It has been most gratifying to see how each one has worked so willingly, tirelessly, and unselfishly for the benefit of our Association.

Let me acquaint you further with the year-round operations of your Association. Our secretary's job is the most time-consuming. It requires many hours of work each week throughout the entire year. Frank Squires has made a fine secretary, and we are indeed fortunate to have such an efficient, conscientious, and capable gentleman devoting so much time to our Association.

I now know that our committees are also in operation throughout the year, and that each committee is kept busy by its individual problems, all of which are handled to benefit the members of the Association.

Since these committees are composed of members of the various constituent societies, the actual operation of our Association reverts to the constituent societies—a decentralizing process which results in the unbiased operation of our Association.

Actually, the American Association of Orthodontists is composed of *ten* separate units: the eight constituent societies, the American Board of Orthodontics, and the AMERICAN JOURNAL OF ORTHODONTICS. Each of these units, to

Presented at the Forty-ninth Annual Session of the American Association of Orthodontists, Dallas, Texas, April 27, 1953.

be most effective, must operate independently of each other, with the sum total of their individual efforts becoming the motivating forces of the American Association of Orthodontists.

The American Board of Orthodontics has been one of the outstanding influences in bringing about wider recognition of our specialty and increasing its prestige.

It was the American Board of Orthodontics that worked with the Council on Dental Education of the American Dental Association to establish acceptable requirements for the diplomates of the Board so as to assure proper recognition of these diplomates. Joseph D. Eby and Bernard C. de Vries were members of the Board who spent many hours on this project.

The present members of the Board and also the past members, are men of great ability, unlimited energy, and of broadest viewpoints toward the entire field of orthodontics. Board members give generously of their time and efforts throughout the entire year. These self-sacrificing men deserve the gratitude of every member of the American Association of Orthodontists.

The AMERICAN JOURNAL OF ORTHODONTICS is the other separate unit that completes our Association. Our JOURNAL is the oldest specialty group journal in dentistry, having begun publication in 1916, and it has never failed to appear monthly since that time. The publication of our excellent JOURNAL requires that it be staffed with time-tested personnel who have a sincere, unprejudiced interest in every phase of orthodontics. Such is its present staff.

Unquestionably, one of the main reasons for the great advance of our profession is that we have been privileged to have this progressive JOURNAL in which to publish our articles. No other dental Journal has opened its pages to the many trends of a specialty as has the AMERICAN JOURNAL OF ORTHODONTICS throughout its many years of existence.

Orthodontic thinking has been more varied in the last few years than at any time since the founding of our profession, and under Editor-in-Chief Pollock and the eight associate editors from the constituent societies every trend of thought has been printed in the pages of our JOURNAL. We are fortunate to have Dr. H. C. Pollock, a man of acumen, foresight, and integrity, as the editor-in-chief of our JOURNAL.

The sectional editors of our JOURNAL, one from each constituent society, furnish the manuscripts which make up the JOURNAL. All these manuscripts are published to benefit our entire profession. Even with its present excellent staff, our JOURNAL has its problems.

The main problem is the delay incurred in publishing our papers. This is often caused by papers not being ready for publication at the time they are presented, usually due to their having more than the maximum number of illustrations allowed by the Editorial and Publication Board of the American Association of Orthodontists. This Publication Board, one of our Association's elected committees, after careful consideration in Louisville, set up a budget for the cost of the illustrations for each manuscript. Extra illustra-

tions may be paid for by the author. Thus, the solution to this problem is simple—use as many illustrations as we wish when presenting our papers, but reduce the number of illustrations to the required maximum and have the paper ready to turn over to the Program Chairman for publication immediately after presenting. The Program Chairman can be of great help in demanding that these requirements be met.

The complaint filed by the Federal Trade Commission came as a most unpleasant surprise, as we had been given to understand only a few months before that the file on the American Association of Orthodontists had been closed.

Even more shocking was the wording of this original complaint by which orthodontics was removed from the ranks of the professions and placed in the position of being a trade and in competition with other trades. Our attorneys, by acting promptly and by establishing concisely and without equivocation the true status of orthodontics, were able to get this commercial wording changed so that orthodontics was restored to its rightful position of being a profession rendering necessary health services.

Many members of the Association feel that the commercial wording of the original complaint by the Federal Trade Commission was brought on by the tendency of orthodontists in the last few years to mention materials, types of appliances, and even techniques for manipulation of these appliances to our patients. This use of tag names placed us on a trades level rather than on our proper professional level.

We seem to have lost sight of the fact that it doesn't make any difference what material we use, what appliance we use, what technique we use, as long as our patients have the benefit of conscientious orthodontic care as our contribution to their other health services.

We also seem more prone to criticize our colleagues than in past years. In my opinion, it is beneath the dignity of orthodontics and orthodontists to criticize the methods used by our colleagues. Such criticism is, after all, a criticism of orthodontics as a whole. The present open bickering concerning materials, appliances, and techniques has decreased the esteem in which orthodontics has always been held. We are making ourselves ludicrous in the eyes of our fellow dentists and the public; and nothing so quickly destroys prestige as derisive laughter!

It is our privilege to be practicing the most fascinating, the most enjoyable, and the most difficult specialty of dentistry. Let us do so with dignity and proper respect for our fellow practitioners.

Our American Association of Orthodontists is one of the most highly respected of all the professional organizations. This respect has not been easily acquired, but has been attained by the untiring and unselfish efforts of such men as Case, Angle, Ketcham, Dewey, Mershon, and many others throughout the years since our founding in 1901. Since its inception, the American Association of Orthodontists has been the clearinghouse for many ideas, theories, and mechanical techniques, and it has presented all essayists and clinicians in an impartial manner.

As our membership has increased, we have been able to take a more active part in rendering health services. There will be no question of our intent as long as we render these health services in a highly ethical and unbiased manner. We must bear in mind that it is the knowledge that each of us has of the many phases of the field of orthodontics that makes us orthodontists; that our orthodontic knowledge is not confined to mere mechanics.

With this thought, let us amalgamate our differences concerning materials, appliances, and techniques and present a united front to the public and our dental colleagues. Let us confine the criticism of our fellow orthodontists to our own orthodontic meetings.

In my opinion, we should begin the amalgamation of our profession at its very base—the dental school orthodontic departments. The present great variation of methods of undergraduate, graduate, and postgraduate orthodontic instruction is resulting in useless, dangerous, and unpleasant confusion. It seems to me that a more standard schedule of orthodontic instruction of all types must be set up in our dental schools if the orthodontic profession is to continue to maintain its position as a necessary, adequate, and popular health service.

With this in mind, your Board of Directors voted yesterday to appoint a special committee to endeavor to work out the details for more standard requirements of orthodontic instruction. This special committee was suggested by the Great Lakes Society. To me, this is a step toward protecting the public from inadequately trained orthodontists, and will further elevate the standards of our profession.

It is not my intention to go into the work of the various committees, as full reports will be made by each, but I do want to mention the all-important Public Health Committee, consisting at the present time of Herbert K. Cooper, B. Holly Broadbent, L. Bodine Higley, Stephen C. Hopkins, and J. A. Salzmann, Chairman. This committee has operated, and continues to do so, as the contact between the American Association of Orthodontists and the United States Public Health Service, the American Public Health Association, and many other groups that are interested in any phase of orthodontics.

The services this Committee has rendered our Association cannot be brought to our attention too often. Dr. deVries made several pertinent comments concerning the Public Health Committee, in his President's address in St. Louis, which I think bear reiterating. Dr. deVries said:

> "It is important that those interested in public health, be definitely made aware that the American Association of Orthodontists wishes to use its influence in elevating the health standards of American children. This is our prime objective as an organization and for the American Association of Orthodontists to be left out of any deliberations concerned with child health would be a calamity. Our organization stands ready to live up to its professional responsibility and wishes to help in guiding whatever policies may be developed later on.
>
> "There is now recognition on the part of the public of the significance of certain types of dental malocclusions as crippling deformities. Thus, public recognition alone places orthodontics in the group of major health services. This is our responsibility and our assumption of it now indicates that when any state feels

impelled to consider the problem of orthodontic services for the underprivileged, it will approach the orthodontic profession of that state. Any plan which is worked out must assure to the patient the highest quality of orthodontic service.

"Such a plan has been devised and is in operation in both the City and State of New York. The request to formulate a plan for the administration of orthodontic services to underprivileged children came from the State of New York to the orthodontists in that area. This is significant. The plan was worked out with the aid of outstanding orthodontists and has been in operation sufficiently long to give evidence of its practicability."

This Public Health Committee, working with the Public Relations Committee, enables our Association to emphasize to the public, to interested groups, and to our governmental agencies that orthodontics is a necessary public health service.

As I mentioned before, our committees are responsible for the integrated operation of our Association. I am most grateful to each committee and every committeeman for their work throughout this last year.

I think that you will agree with me that your Program Committee—Leo Shanley, Dick Smith, with Charlie Baker as Chairman—has done a masterful job in compiling this program. To them, I wish to express the appreciation of the Association.

The Local Arrangements Committee, headed by Tom Williams, has also done a great piece of work. These men with the ribbons on their lapels are at your service during your stay. Please call on us at any time.

It has been my privilege to work with one of the most conscientious, efficient, and diligent group of officers that has ever served our Association. President-Elect Ford, Vice-President Madden, Secretary Squires, and the other Ad Interim Committee member, George Siersma, have spent many hours in the service of our Association and deserve our sincere thanks.

One other Committeeman should receive special mention: the Chairman of the Public Relations Committee, Fred Aldrich. Fred has spent untold hours working with our attorneys to bring about a satisfactory settlement of the Federal Trade Commission complaint. He too should receive our unlimited thanks.

I want to thank the essayists and clinicians whose contributions have made this excellent program possible. The members of the Association and our guests appreciate the many hours you have spent in preparing your subjects. I also wish to thank the exhibitors who each year come many miles to participate in our meetings.

In closing, it is not possible for me to express my appreciation for the privilege of having served as your President. It is an honor I shall always treasure.

CLOSING REMARKS OF DR. BROOKS BELL, PRESIDENT OF THE AMERICAN ASSOCIATION OF ORTHODONTISTS

I PRESUME that brings to an end the business session, but, before turning the gavel over to your installing officer, I want to express my appreciation to all of you for your cooperation and participation in this meeting.

I am greatly indebted to P. G. Spencer, H. C. Pollock, Joseph D. Eby, James D. McCoy, Oren A. Oliver, Leigh C. Fairbank, Philip E. Adams, Bernard G. deVries, Max Ernst, and the others of my Advisory Committee for their helpful advice throughout the year.

I know that you will join me in saying "thanks" to our Program Committee—Charlie Baker, Dick Smith, and Leo Shanley. I think they have put on one of our Association's finest programs.

I extend congratulations to the retiring president of the American Board of Orthodontics, Dr. Leuman M. Waugh, for the fine work the Board has done in behalf of our Association, and I extend felicitations to the new president of the Board, Dr. Raymond L. Webster.

As I mentioned previously, the efficient operation of our Association depends upon the coordinated work of our committees.

I want particularly to thank the members of the Ad Interim Committee—Jim Ford, Clare Madden, Franklin Squires, and George Siersma for their helpful advice throughout the year. I am deeply obligated to each of them.

I also am obligated to Fred Aldrich for the many hours he has worked as Chairman of the Public Relations Committee.

I am indebted beyond measure to my local and Southwestern colleagues for the immense amount of work they have done:

Tom Williams, as chairman of the Local Arrangements Committee, has spent hours on the details of our meeting.

Frank Roark, as treasurer, has kept a close Scotch eye on our expenditures. Frank was also responsible for all property used during our meeting.

A. B. Conly and Robert E. Gaylord with their committees have provided the enjoyable entertainment for our meeting.

The excellent publicity was handled by Joe Favors, assisted by G. A. McJimsey and the other members of the Press Committee.

Bibb Ballard and his committee were in charge of the efficiently operated registration desk.

Horace Wood and Harrel Delafield and their committees also cooperated in making our meeting run smoothly.

Julius Tomlin and his committeemen were responsible for the fine Table Clinic setup, which they spent many hours in planning.

Given at the closing meeting of the Forty-ninth Annual Session of the American Association of Orthodontists on April 30, 1953, Dallas, Texas.

Nat Gaston arranged and handled the excellent facilities available for our exhibitors. From all reports, these exhibitors are well pleased.

We have all been helped immensely in our various duties by John Conly, Jim Hart, and Tom Matthews, who will soon become active members of the Association.

To all of these and their committeemen, I express my sincere thanks.

I particularly thank Joe Favors and Frank Roark for the advice and help they have given me throughout this year.

I thank all of you for the honor and privilege of having served as your president.

If I may, I would like to quote a little poem:

> No words the speaker spoke were quite
> So welcome to the dozing,
> So full of wisdom, truth and light
> As "Now, my friends, in closing."

THE NATURE AND PLACE OF REMOVABLE APPLIANCES IN ORTHODONTIC TREATMENT

ANDREW FRANCIS JACKSON, PHILADELPHIA, PA.

IN DISCUSSING orthodontics it is necessary to start with a factual background, comprehensive enough to cope with the inescapable element of infinite variation, as only on this basis can all the problems in orthodontics, from fundamental concepts to the nature and uses of appliances, find their logical and harmonious relation to each other.

The first and most important fact in orthodontics is that every human being is the direct result of his own peculiar heredity and environment and, as such, is invariably unique within a very wide range of quite natural and normal individual variation.

Unless something definitely pathologic is present, the resultant combinations of component elements are both natural and normal for the specific individual. This, however, is very rarely ideal, and in the majority of cases it is very far from being even remotely satisfactory.

Nature rarely produces perfection in anything, least of all in anything as fantastically complex as the human organism. That is why we have so few Hollywood stars or mental geniuses in the world.

The human population is estimated at being over two billion living individuals, of whom more than 160 million specimens of the most mixed varieties on earth are intermingling and crossbreeding in the most heedless and haphazard manner in our own country, completely ignorant of and indifferent to the laws of genetics which include, among other factors, the element of hybridization with results which are quite unpredictable and often very unfortunate as far as certain specific individuals are concerned.

Orthodontics is, consequently, mainly the science and art of dealing with unsatisfactory genetic patterns.

One of the commonest errors is to confuse our concept of the ideal with normality. In the human being normality, although concretely indefinable as to any specific individual, can be estimated only on the mean or average of a group. On this basis, as compared with our concept of the ideal, it is therefore quite normal and natural to be fairly ugly, inefficient, and stupid.

This naturally is not satisfactory for what we would like for ourselves and for those unfortunates whom we have so ignorantly and heedlessly been instrumental in bringing into this world. As the teeth and their surrounding tissues are amenable to improvement if approached with some degree of intelligence, the specialty of orthodontics has come into being, suffering though it is at

Read before the American Society of Orthodontists, Dallas, Texas, April 28, 1953.

present from the growing pains of youth and the inherent ignorance, stupidity, and intolerance of those of us who have applied ourselves to the fantastic complexity of its problems.

In the invitation to read a paper before this meeting, I was asked to present something on a particular appliance.

The term "appliances" naturally suggests the mechanics of their construction and uses, and usually carries with it the tacit, but often unflattering, implication that those who are particularly interested in them may not be sufficiently scientifically minded. If I have not dispelled this implication to some extent in my opening remarks, I would like to amplify this by repeating a definition of orthodontics which I presented in a previous article (AM. J. ORTHODONTICS **38**: 485, 1952).

"In its broad comprehensive aspect, orthodontic practice actually consists of bold and audacious attempts to alter the entire natural genetic and functional patterns of certain specific, unique, infinitely variable, scientifically incalculable and unpredictable human individuals. These changes include their teeth, bones, temporomandibular joints, and esthetic facial proportions. To be more specific, the factors involved include the whole gamut of heredity and environment, the infinite variations and combinations of anatomic proportions, physiologic functions, psychologic motivations and habits, diseases, endocrine unbalances, traumatic injuries, mutilations, and gross abnormalities. The resultant composite combinations which all these factors with their infinite variations are capable of producing must be appraised and balanced by the world-be orthodontist into single, all-inclusive, specific and individual mental pictures, and when judged unsatisfactory altered by natural and artificial means into other specific, unique, all-inclusive, three-dimensional arrangements which will remain in satisfactory and stable conditions of structural, functional, and esthetic equilibrium. . . . Brash has well defined it as the 'experimental control of the experiments of nature.' "

On a purely scientific basis, the practice of orthodontics is, and always will be, completely impossible for the simple reason that infinite variation, whether in orthodontics or anything else, cannot conform to any obviously futile attempts at exactness of formulation which are based on hopelessly inadequate statistical, quantitative, dimensional, or orientative plans which leave out of consideration functional and volitional elements which are quite impossible of exact scientific calculation. Perhaps the first and most important step in orthodontic understanding is to recognize this basic truth and not to be misled by narrow-minded systems which are not only out of harmony with these basic facts, but in some cases openly trample on some of the most valued scientific principles which we have already so laboriously discovered.

If the differences of opinion which at present exist between orthodontists are ever to find a logical and satisfactory solution it can be only on the basis of a common agreement on some very broad generalities and the clinical use of some principles of treatment of universal application to infinite variation. On this broad basis alone will the numerous and totally different concepts and methods of treatment, including appliances, find their logical and final places of definite usefulness.

It has been said that anyone who has grasped a "principle" or "method of approach" which is universal in character has in his hands the only weapon applicable to infinite variation. Techniques are mere servants to principle. When anyone takes over the technique of a predecessor without sharing the vision which animated it, he takes over a mental body but loses its immortal soul.

Orthodontic appliances are the activating mechanical means whereby orthodontists alter the anatomic relations, functional activities, and esthetic proportions of the teeth and surrounding tissues.

The judgment exercised in their selection, as to the place and time of their uses, is the determining factor and final expression of the orthodontist's philosophic, scientific, and artistic concept of the subject, because in practically all cases they are the indispensable elements necessary in attaining the results he wishes to produce. They are to the orthodontist what brushes are in the hands of an artist or clubs in the hands of a golfer.

Regardless of what the basic idea may be in the mind of an artist, it will die without the physical means and manual dexterity necessary to carry this mental picture to a finished result which can be critically analyzed and judged on its final merit. Results and the way they are attained are the final and only real tests of a good artist, a good golfer, or a good orthodontist. It would be just as absurd to try to limit an artist to the use of one brush, or a golfer to one club, as to try and limit an orthodontist to one type of appliance. Any philosophy or system based on such a premise only shows a woeful lack of knowledge of the true nature of orthodontics and the biologic laws which govern and determine the changes which are both desirable and possible of achievement.

It also stands to reason that the simpler the appliances and the more clearly the operator can see for himself at each successive step in treatment the actual changes which are taking place, the more likely he is to save himself from the pitfalls into which time-consuming, mentally confusing, complicated appliances are likely to enmesh him. The acid test of an artist is the breadth of concept and the simplicity and directness with which he can attain his practical objectives.

Simple appliances, devised on sound mechanical principles, and in harmony with the biologic laws of nature, which insure stable anchorage for all the teeth it is desirable not to move, pitted with gentle continuous pressures against those it is desirable to move, constitute, in a large percentage of cases, an ideal setup for the changes which it is possible and desirable to make.

The first and most important principle or act of procedure in treatment is to study and compare the natural occlusion with what has been fully described in previous papers as the position of "optimum occlusal relation."

This is the nearest approach to reducing to a single mental picture the entire panorama of any case with its individual problems and the means of treatment best suited to them.

The second principle consists of devising for each successive step in treatment the appliances best suited to the problems of the moment, coordinating

the actions of the appliances used in the opposing jaws in order to avoid all possible trauma and allow the utmost freedom of movement of both the jaws and teeth while changes are taking place.

The third principle of treatment is that as action is followed by reaction, which is never quite predictable, a complete re-evaluation of the entire case should be made at each visit of the patient. The position of optimum occlusal relation should be constantly studied in minute detail. Depending entirely on the changes which have taken place between visits, the decision should be made whether to continue with the means which are being employed, or to discard them for something entirely different, either because the effect has not been what was expected, or the desirable changes which have been obtained suggest something entirely different for the next move.

Treatment is based on strategy from start to finish; not the strategy of this or that appliance, but an all-inclusive strategy which may include the use of all types of appliances as long as they are used at the time best suited to the problem of the moment.

In making the changes which the orthodontist, in his judgment, may think desirable, he has at his command four means to produce tissue readjustments.

Two of these means take full advantage of nature's natural unaided efforts at anatomic and physiologic readjustments. The other two means are extraneous and artificial mechanical forces.

1. *Surgical interference,* which includes osteotomies and ostectomies in extreme cases and that most controversial of all orthodontic subjects, the extraction of teeth.

2. *Natural tissue readjustments* constantly operative throughout life due to growth, development, and functional changes, and particularly noticeable and active after the extraction of teeth.

3. *Induced tissue readjustments,* either by unhampered volitional functional muscular efforts or induced by passive mechanical interferences such as bite planes, guide planes, cribs, etc.

4. *Artificial mechanical pressures,* produced by orthodontic appliances of all kinds and descriptions.

It stands to reason that in the course of treatment the less the forces of nature are interfered with by mechanical appliances, and the more the tissues can be altered by natural readjustments and induced functional changes, the more logical and natural is the treatment. This basic concept of treatment is diametrically at variance with the principles and methods employed in systems where all the teeth are banded, nature is hamstrung, and all the changes are subject to the skill of the operator and the mechanical limitations of a specific appliance.

The specific purpose of this article is to describe in detail the mechanical construction and uses of an appliance which does not employ any bands, but combines many of the most desirable elements of mechanical therapy. It has been used exclusively and with notable success by only a very few, but at the

same time some of our most able, orthodontists and deserves, in my opinion, far greater attention than it has been accorded so far.

As is usually the case, in the early days opinions were divided between the uses of fixed and removable appliances.

A short sketchy history of the so-called Crozat appliance is appropriate at this point. The basic idea had its origin in the fertile mind of one of the early pioneers in orthodontics, the late Dr. Victor Hugo Jackson of New York (no relation of mine). The original Jackson removable appliances or "cribs," as they were usually referred to, were just as crude in their construction with the use of soft solder as were Angle's original expansion arches with the use of threads and nuts in both the arches and the clamp bands. They both have been given college educations by those who have followed.

According to what I have been able to gather, perhaps the man who did the most to initiate the development and improvement of Jackson's original appliance was Dr. Ernest Walker of New Orleans. He died, however, before he was able to give much publicity, if any, to his efforts. No man lives to himself alone, but, whether he wishes or not, leaves imprints on the sands of time. Thus, what Dr. Walker had done in the improvements in the construction of the appliances, as well as the clinical results which he had obtained by the use of them, was clearly evident to those who lived in his city and into whose hands his patients went after his death. It must be remembered that there were very few so-called orthodontists at that time. The merits and possibilities of the appliance were, under the circumstances, therefore very vividly brought to the attention of Dr. George Bernard Crozat, also of New Orleans, who made further improvements and presented a number of clinics of the appliance before orthodontic meetings. These clinics were met with mixed opinions of approval due to the preponderant swing to fixed appliances which had been initiated so strongly by the forceful personality of Dr. Edward H. Angle. Anyone who knows the quiet, gentlemanly personality of George Crozat knows that he would be about the last man in the world to make any undue claims for himself or enter into any heated arguments as to the merits of an appliance which he had found useful to himself. Nevertheless, his name became associated with this appliance in much the same way as Hawley's name has become associated with the improvements he made on retainers, and this was both legitimate and proper in both cases. The two outstanding pupils of Dr. Crozat are and were Dr. Samuel D. Gore of New Orleans, and the late Dr. Oscar Henry of London. Dr. Henry conducted a very successful practice in London, using these appliances exclusively, and my own interest was aroused to a certain extent by some of the excellent results I saw in his office. On the other hand, George Crozat's own interest in removable appliances may have been due to the tutelage he received from our own Dr. Joseph Eby in the construction of Jackson's original appliance.

The objections and shortcomings of Jackson's original appliances were so obvious, both in construction and clinical use, that the well-warranted prejudices against them have been difficult to overcome. A new interest in the vastly improved new appliances can be aroused only by a thorough and detailed knowl-

edge of their construction and a genuine appreciation of the sound, basic orthodontic principles which can be employed in their use, apart from the very desirable features of their removability. It is well, therefore, to start with a detailed and meticulous description of every step in their construction, as only on this basis can anyone derive any satisfaction from their use, and it is well to know from the start that only when this technique has been fully mastered by a considerable amount of clinical experience, including some inevitable failures, that any genuine enthusiasm can be aroused. The last impression in the world that I have any desire of conveying by this article is that these appliances are suitable to all cases or that they are any panaceas for all our orthodontic problems. They are, by comparison, just another useful club in the bag of a golfer, or another brush in the hands of an artist, as has been mentioned before. No man need think for one second that he can save himself from the sweat and toil inevitable in the acquiring of a new technique, and, furthermore, it is to be expected that even with the most careful of efforts the standard of perfection of the first fifty or more appliances is likely to be far from satisfactory.

A. *B.*

Fig. 1.—Trimming the model around the teeth to be clasped is the first important detail to insure accurately fitting clasps.

It is necessary, naturally, to start with a perfect set of stone models. The first step of vital importance in preparation for their construction is to trim the models in the region of the teeth to be clasped (usually the first molars) so as to expose the necks of the teeth slightly below the gum line in the approximate spaces with the adjoining teeth. This is an absolute must and only failures can be expected unless this is done carefully and thoroughly. What this should look like on the models is shown in Fig 1, before and after trimming.

The next all-important step is the construction of perfectly fitting clasps which will insure all the stability which the shapes of the teeth clasped are able to furnish, and this can be obtained only by having the clasps grip the teeth gingivally just beyond their most bulbous circumferences. When this is done perfectly, the grip is so stable that only on comparatively rare, exceptional occasions can intermaxillary elastics not be used with impunity as shown in Fig. 10, *D*.

The bending of the clasps to shape is naturally open to individual preference of procedure, but the steps which are shown in Fig. 2 are the ones which I have copied from those used by Drs. Crozat and Gore, and the result of their thirty years or more of practical experience should be good enough for almost

A. B.

C. D.

E. F.

Fig. 2.—Progressive steps in making molar clasps.

anyone. The fact is that it is an almost unpardonable presumption on my part, with my own short but serious experimental experience of three years, to be writing about this at all. Perhaps I should have left this to the time and discretion of the masters who have taught me what little I know about it. My only excuse is that, while still smarting from the inevitable but stupid mistakes of first experiences, the details which to the master become almost subconscious

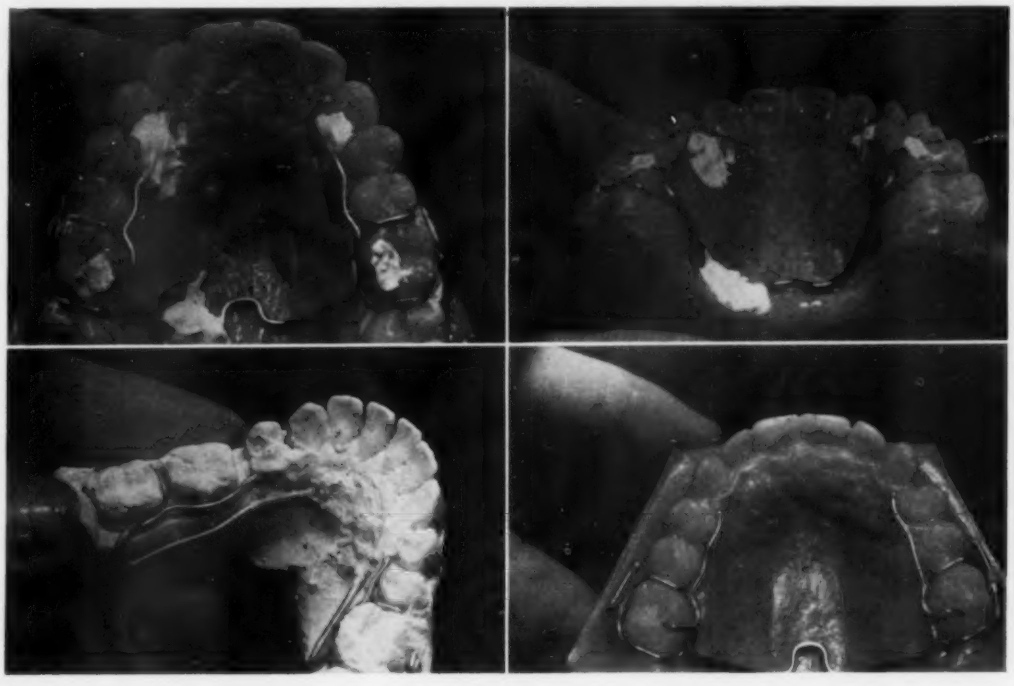
reflexes, are still vivid realities in the mind of the beginner and can, therefore, perhaps be described in detail with more elemental simplicity.

After the one-piece clasp wire has been perfectly bent to shape as shown in Fig. 2, *E*, an additional piece of wire with free ends is fitted along the gingival borders of the clasped teeth on the buccal surfaces of both the maxillary and mandibular teeth which are to be used. The gauge of the wire used for the construction of this clasp assembly is 0.028 inch.

Anchorage is naturally obtained by clasping appropriate teeth on both the right and left sides of the arches and these are connected by heavy 0.051 inch gauge wire which is bent to shape as shown in Fig. 3, *A* and *B*.

Extension wires of 0.036 inch gauge then are added on both the lingual and buccal surfaces, as shown in Fig. 3, *A* to *D*. Also, short pieces are added from the lingual surfaces of the clasp wires over the occlusal surfaces for a few millimeters of length to prevent the clasps from riding too far gingivally.

A. *B.*



C. *D.*

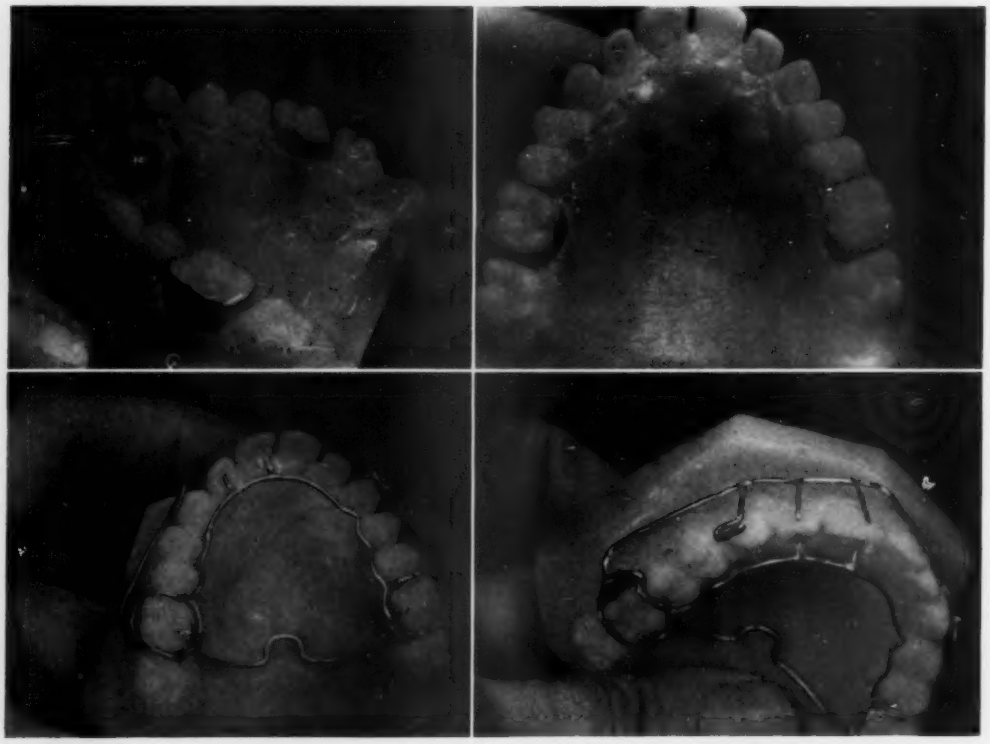
Fig. 3.—*A*, *B*, and *C*, Assembling units and holding them in place on models with small quantities of plaster of Paris using camel's-hair brush dipped in water for purpose as shown in Fig. 16. *D*, units soldered and polished.

As all these pieces are being assembled, they are attached and held in place on the stone models by small amounts of quick-setting plaster of Paris which is mixed by dipping a wet camel's-hair brush in water and then dipping this wet brush into a small container of loose unmixed plaster. In this way just about enough plaster adheres to the wet brush for the purpose (Fig. 16, *A* and *B*).

All the pieces are assembled and held in place with small amounts of plaster as shown in Fig. 3, care being taken to leave all the joints to be soldered entirely free from plaster. The models then are placed on the soldering block, heated up, and soldered with a free flame from a blowpipe. All the joints are soldered at the same time. It is desirable to use high karat gold solder (18 karat) in this first soldering, as it then is possible to drop down to lower karat solders (16 to 14, or lower if necessary) so that repairs or additions may be made to the original assembly without danger of unsoldering those pieces or joints which already have been soldered and which it is not desirable to disturb.

The first original assembly of parts for the maxillary and mandibular units individually should look something like those shown in Fig. 3, *C* and *D*.

A. *B.*



C. *D.*

Fig. 4.—Bands cemented on anchor teeth and appliance tied in place when condition renders this necessary.

From this point on, an infinite variety of both buccal and lingual attachments may be added, limited only by the resourcefulness and ingenuity of the operator, bearing in mind at all times the basic principles of coordinating the movements of the maxillary and mandibular teeth and applying only pressures gentle enough to the teeth to be moved so as not to disturb the anchorage of the teeth which it is *not* desirable to move.

As I have used lingual cribs, guide planes, bite planes, etc., in the way of lingual attachments throughout my orthodontic career, I found no difficulty

in attaching all these forms to the lingual aspect of the Crozat appliances. One example of this is shown in Fig. 4, *C* and *D*.

The appliances may be constructed of platinized gold and this material is used by Drs. Crozat and Gore. After a visit to Denver I found, however, that excellent results were being obtained by Drs. Brusse and Humphrey using other materials, Dr. Brusse using stainless steel and Dr. Humphrey using Tophet metal composed of chrome nickel and manufactured by Wilbur B. Driver and Company of Newark, N. J. I am at present using Tophet metal and find it preferable to gold in many ways.

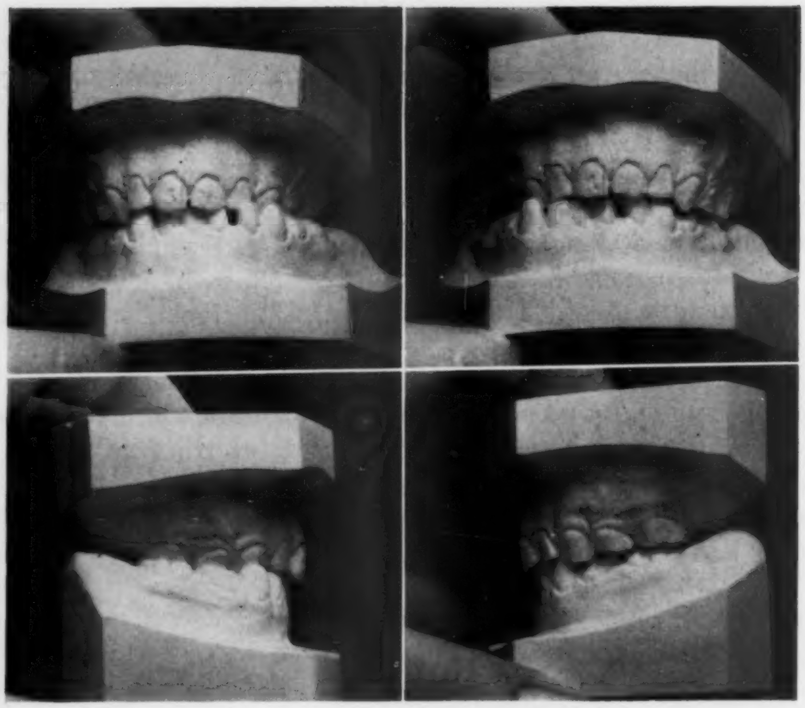
The factor of the removability of the Crozat appliance, as well may be understood, is both an asset and a liability. In cases in which the shape of the molars is unfavorable to obtain a sufficient amount of grip, and also in cases in which the patients will not wear the appliance faithfully, the objections can be overcome by banding the molars and attaching lingual hooks, as shown in Fig. 4, *A* and *B*. The Crozat appliance then can be constructed in the usual manner, care being taken to take the impression *after* the molar bands have been cemented in place. The appliance can then be tied to the lingual hooks as shown in Fig. 4, *C* and *D*. This has proved exceedingly effective in my practice.

To those who are unfamiliar with the use of the Crozat appliance, the first question asked is nearly always, "How do you get the youngsters to keep these things in place?" Figs. 5 and 6 are of a child five and one-half years of age and, as will be shown by the models, this was a case of cross-bite, the child being able to bite as shown in Fig. 5, *A* and *B*. This case was treated entirely with the appliance shown in Fig. 6, *C* and *D*. The expansion of the maxillary arch was produced entirely by opening the loop of the palatal bar. It will be noted that the attachments were on the two deciduous second molars.

At this point it might be well to emphasize very emphatically that there are certain movements that can be effected with Crozat appliances which are comparatively easy and involve very little risk of doing any damage, and others which require a great deal of skill. All of the movements which involve changes in the position of the anchor teeth are the ones which require great skill in order to avoid producing damage to the tissues and involving the operator in technical difficulties. The expansion in the deciduous molars which was produced as shown in Fig. 6, as already mentioned, was produced by opening the loop of the palatal bar. This is done by making very accurate and careful bends and requiring the use of a special pair of pliers to do it most effectively. These pliers are S. S. White Dental Manufacturing Company No. 112. I would strongly advise the beginner not to attempt a movement of this kind in his first case and, even after gaining a considerable amount of experience, to feel always that he is treading on very dangerous ground. The amount of expansion at each time should not exceed 1 to 2 mm., and this can be measured by placing the appliance on a piece of paper and marking the end of the landmarks which may seem desirable and then placing the arch which has been altered over these landmarks so as to see exactly how much change has been produced.

The case shown in Figs. 7 and 8 is, in my opinion, an ideal case for the use of the Crozat appliance. The position of the anchor teeth is not disturbed at

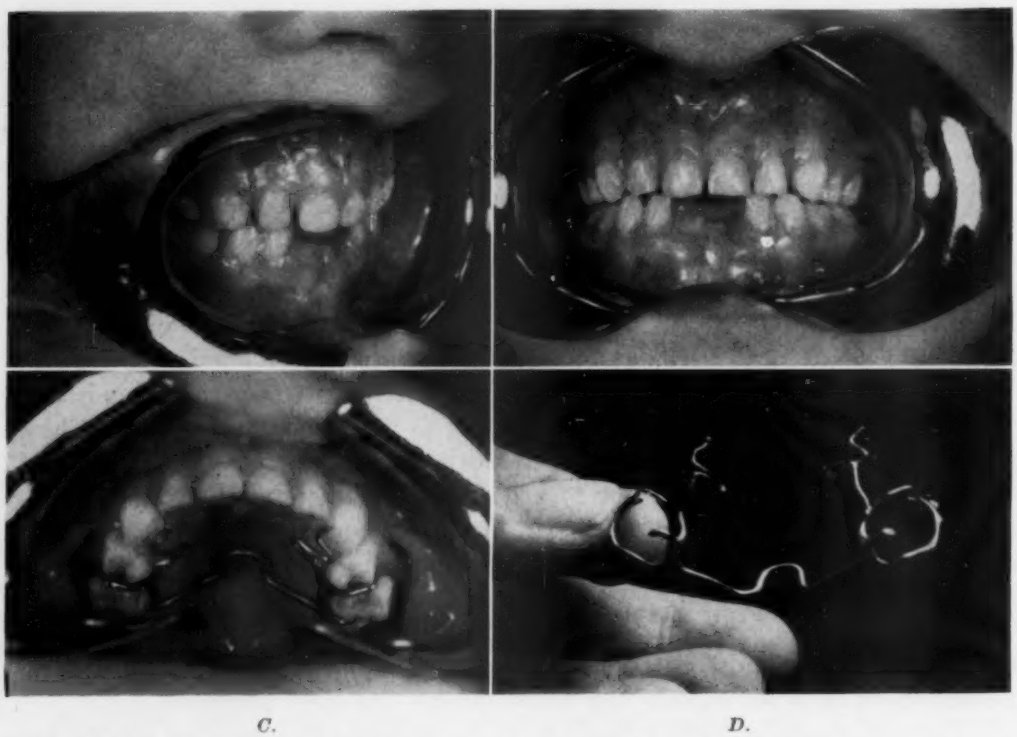
A. B.



C. D.

Fig. 5.—Models of patient 5½ years of age with cross-bite treated entirely with upper Crozat appliance.

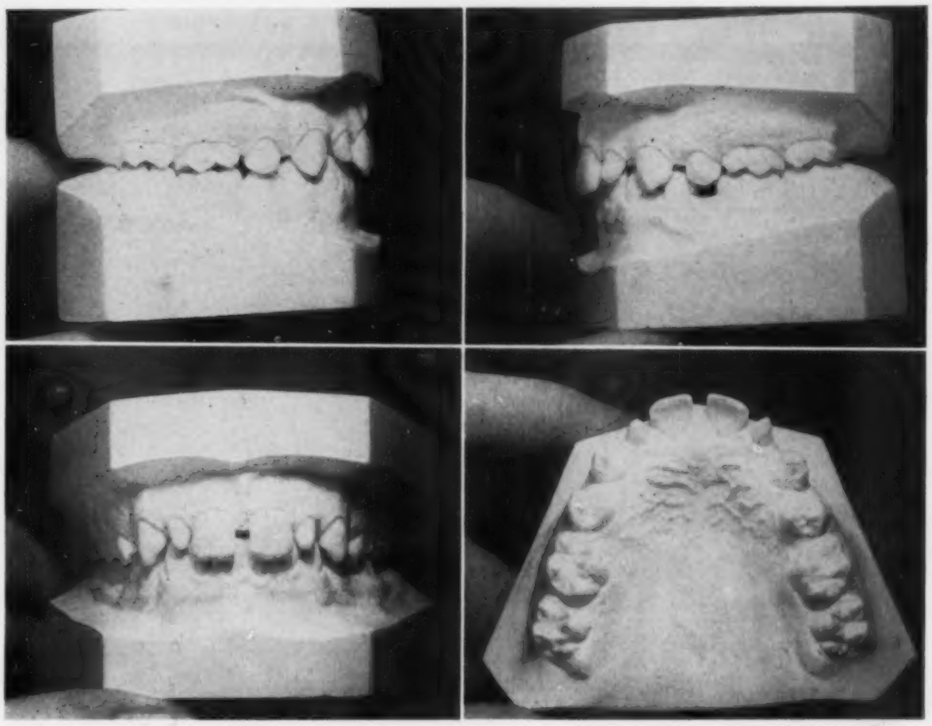
A. B.



C. D.

Fig. 6.—Result of treatment of case shown in models in Fig. 5. *A* and *B*, Improvement in occlusion; *C* and *D*, appliance used, in and out of mouth.

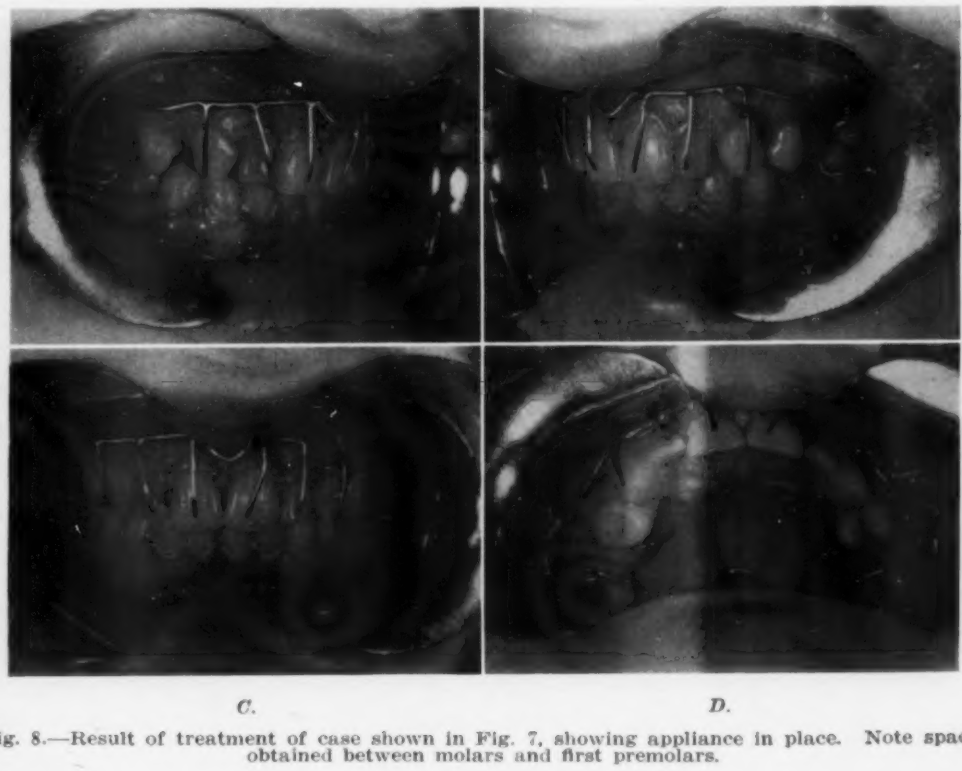
A. B.



C. D.

Fig. 7.—Models of an ideal case for treatment with Crozat appliance. Rigid anchorage for molars and gentle continuous pressures on teeth to be moved.

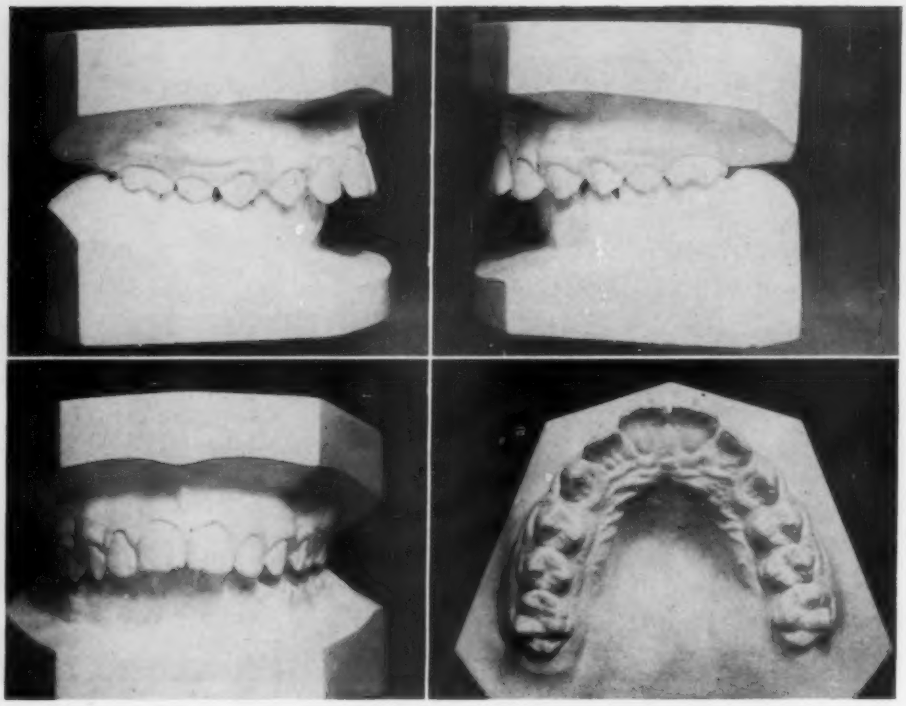
A. B.



C. D.

Fig. 8.—Result of treatment of case shown in Fig. 7, showing appliance in place. Note spaces obtained between molars and first premolars.

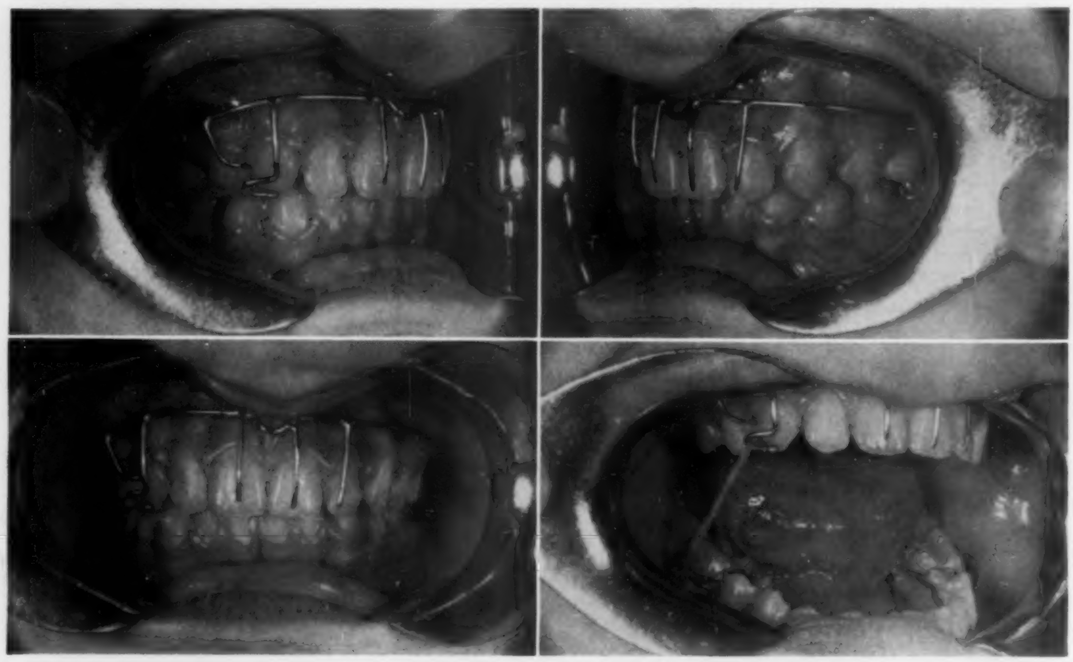
A. B.



C. D.

Fig. 9.—Case of distoclusion treated with Crozat appliance and intermaxillary elastics.

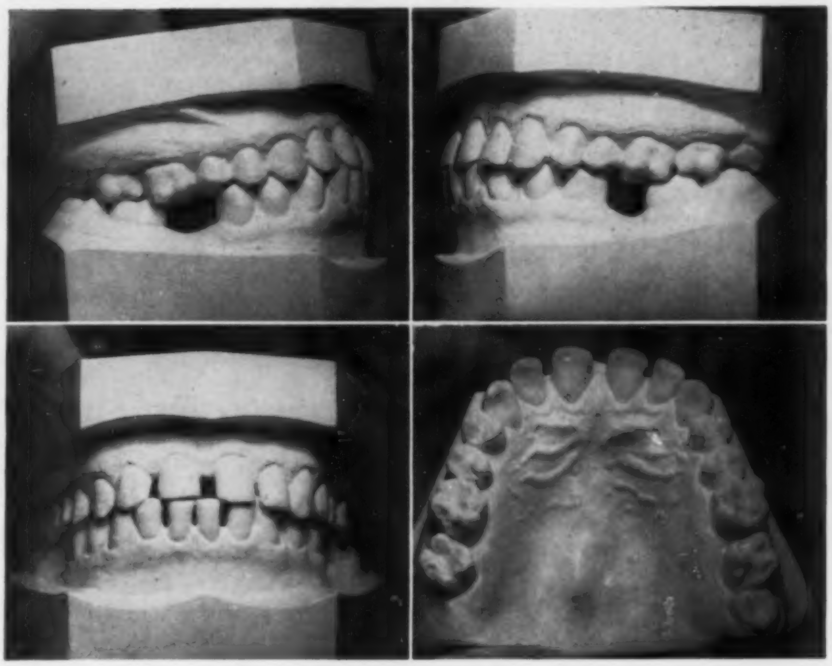
A. B.



C. D.

Fig. 10.—Result of treatment of case shown in Fig. 9. Note stability of appliances with use of intermaxillary elastics.

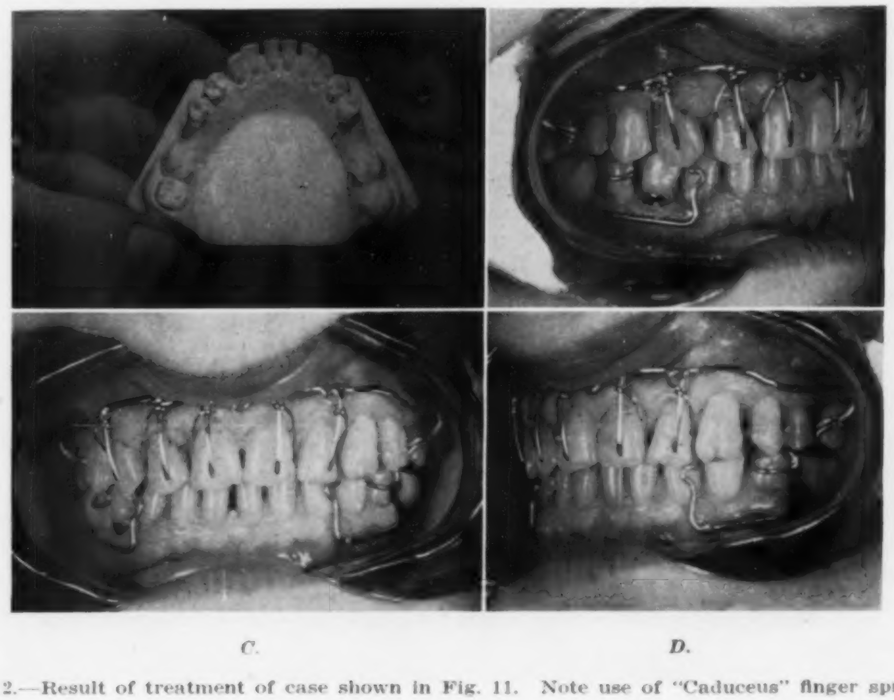
A. B.



C. D.

Fig. 11.—Models of adult case amenable to some orthodontic improvement.

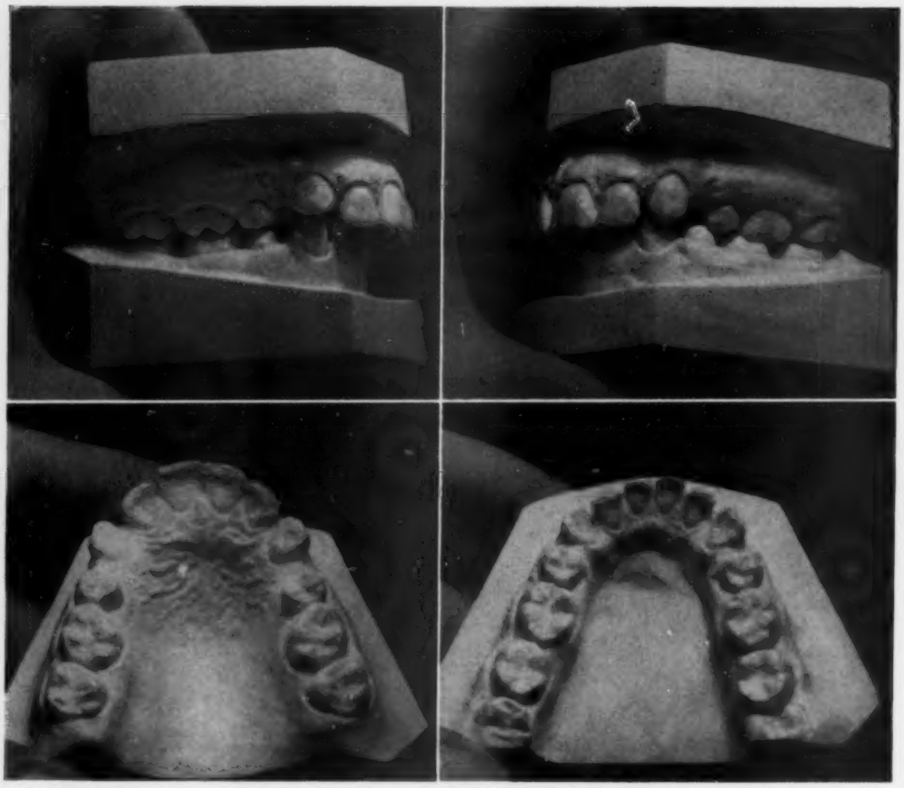
A. B.



C. D.

Fig. 12.—Result of treatment of case shown in Fig. 11. Note use of "Caduceus" finger springs.

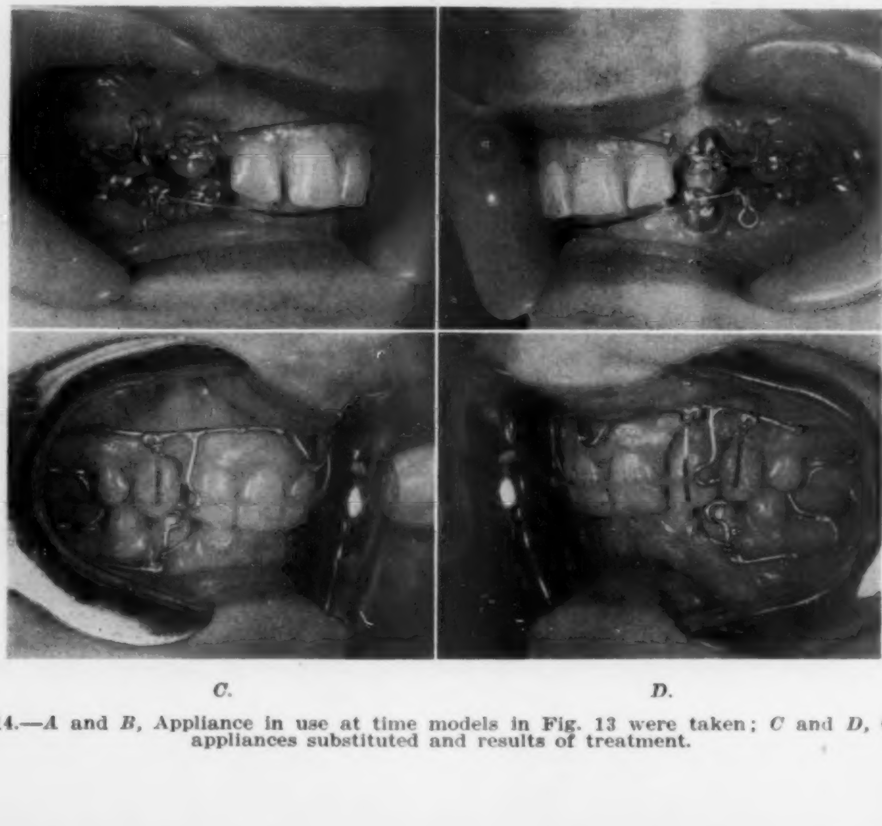
A. B.



C. D.

Fig. 13.—Models of case taken over at this stage. Previous treatment consisted of removal of four premolars and edgewise technique therapy.

A. B.



C. D.

Fig. 14.—*A* and *B*, Appliance in use at time models in Fig. 13 were taken; *C* and *D*, Crozat appliances substituted and results of treatment.

any time and the movements of the teeth which it is desired to move are effected by gentle finger springs from either the labial or the lingual extension of the appliance. It will be noted that the positions of the second maxillary premolars have been moved mesially the distance of an entire tooth by the use of lingual auxiliary springs and that the incisor teeth have been aligned by auxiliary springs on the labial arch.

As mentioned in a previous paper, the gentle movements of single teeth can be effected very nicely by winding around the labial prongs a fine wire of 0.020 platinized gold in the form which the snakes assume in the symbol of Caduceus.

One of the advantages of the Crozat appliance is that after the changes have been produced the appliance itself acts as a retaining appliance for as long as it is desirable to wear it so that there is no conscious change in the feel of things to the patient as there is when all fixed appliances are removed and the usual type of retainer is inserted.

A. *B.*

C. *D.*

Fig. 15.—*A* and *C*, Condition due to automobile accident; *B* and *D*, change produced by one adjustment of Crozat appliance while patient was at college.

In the case shown in Figs. 7 and 8 the two peg-shaped lateral incisors have been covered by acrylic caps by the patient's dentist, and I might remark that I think he could have done a better job as to the selection of his color.

The case shown in Figs. 9 and 10 illustrates a very common type of distoclusion. This patient was treated for a very short time with fixed appliances and then the Crozat appliances were inserted as shown in Fig. 10, with a continuance of the intermaxillary elastics on the right side. This case is now in exceedingly good shape and the whole treatment took less than one year's time.

Figs. 11 and 12 are of an adult patient. The use of the Crozat appliance in adult cases opens up an almost unlimited field of usefulness, not only in

improving conditions in which fixed appliances would be undesirable, but also in doing preparatory work for restorative dentistry prior to the construction of bridges, etc. The closing of the unsightly spaces which were prevalent in this case in both the maxillary and mandibular incisors was effected by the use of

A.

B

Fig. 16.—Laboratory techniques. *A*, Assembling the pieces with plaster; *B*, soldering all the points at the same time.

labial prongs in the maxillary teeth with caduceus attachments on most of them, as shown in Fig. 12. To the mandibular Crozat appliance teeth were added in the space which are shown in the models and labial hooks were constructed at the position between the lower canines, to which one strand of thin latex elastic

was stretched. This closed up all the spaces and furnished the patient, in the meantime, with what amounted to a very satisfactory removable bridge. This particular patient was effusive in her satisfaction with the changes that had taken place.

If we are going to get anywhere finally in our orthodontic differences of opinion, this can be accomplished best by a comparison of basic ideas and then of the efficiency with which the actual changes are carried out.

The case shown in Figs. 13 and 14 is a patient who came to me after the death of her former orthodontist. In this case the second molars, the first molars, the second premolars, and the canines all had been banded and the appliance shown in Fig. 14, *A* and *B* was in place at the time I took the case over. In my opinion, there was no necessity whatsoever for having extracted the four premolars, but, as this was already a *fait accompli,* there was nothing that could be done about it. However, I removed the appliance which had been in use and substituted it with the Crozat appliances shown in Fig. 14, *C* and *D*. The basic idea of keeping the anchor teeth immovable while the incisor teeth were being moved distally is exactly the same basic idea whichever way it was desirable to treat the case. As a matter of comparison, therefore, I think it is far more desirable to treat it with an appliance which can be removed *in toto* in a matter of seconds and in which the individual movements can be made with great simplicity and by means of auxiliary springs with very gentle pressure.

The efficiency of the human body as a working mechanism is one of the marvels of creation and it works on the basic idea of a body for stability, arms for the secondary movements, and fingers for the finest movements which it is desirable to make. As I have said in a previous paper, the idea of having one gauge of wire to act as body, arms, and fingers does not seem practical to me.

The case shown in Fig. 15 is one in which a young lady, the daughter of one of my very good dentist friends, met with an automobile accident. This happened just before she was due to go to college in the fall and it was imperative that she should get there within a few days. Under the circumstances, I constructed the appliance shown in Fig. 15, *D*, and I did not see her again for more than two months. The gentle pressure from the maxillary springs produced the changes which are shown in the illustrations, and did so practically without any pain or discomfort. I would like to ask anybody, whatever his orthodontic convictions may be, if there is any appliance which could have effected the changes which were produced any more simply, or with better results. Naturally, at the time this appliance was inserted, the tissues were exceedingly tender and it can be noted how far the teeth which remained in the mouth had been displaced. From the operative standpoint, all that was needed was to take a careful D.P. impression, construct the appliance in the laboratory, and place it in the mouth. I think this should be at least one argument in favor of considering the Crozat appliance as being a very useful addition to anybody's repertoire of orthodontic techniques.

MEDICAL ARTS BLDG.

THE GROWTH OF THE PALATE AND THE GROWTH OF THE FACE DURING THE PERIOD OF THE CHANGING DENTITION*

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STATEMENT OF THE PROBLEM

FACIODENTAL growth has been the subject of many investigations. A number of studies have centered around the palate size and form, while others have dealt with facial size and pattern. So far as we can ascertain, no single study has combined a correlation of these two types of growth analysis in the same series of children. Berger[1] was perhaps the only one who studied the relationship of bimolar breadth with the bizygomatic breadth and conclusively stated that in adult skulls the bizygomatic breadth was three times the bimolar breadth. With this exception, one piece of research has focused upon the palate, another upon the face. There has been no correlative palatofacial analysis upon the same individual or the same group of individuals over a period of time.

Various investigators have studied the growth and development of dental arches. Gilpatrick[8] was among the first to try arch predetermination by measuring the arch width from the buccal pit of the right upper first molar to that of the left upper molar. Hawley[10] availed himself of Bonwill's[2] study of 6,000 skulls and 4,000 dentures to prepare his charts for arch predetermination.

Goldstein and Stanton[9] have given us their study of the growth of jaws from 546 sets of casts of 300 children ranging in age from 1 to 11 years. Their evaluation of dimensional changes is, perhaps, the most elucidative we have so far.

Lewis and Lehman[16] limited themselves to the study of the bicanine width. Cohen[5] set up a study at the Institute of Child Welfare at the University of Minnesota to evaluate the dimensional changes in the jaws of twenty-eight children (fifteen boys and thirteen girls). He has a series of 271 casts. These casts were made annually during the period of mixed dentition.

Wallace,[20] Sillman,[19] Munblatt,[18] Friel,[6, 7] and others have contributed toward deeper knowledge of the growth of the jaws.

Our problem, therefore, is the correlative study of dimensions of the palate and those of the face. With this in view, we first gathered cross-sectional data on palatal arch dimensions in some 600 Philadelphia school children, aged 7 to

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This thesis received honorable mention in the Essay Contest of the American Association of Orthodontists in 1952.

12 years.* Second, we have secured facial dimensions on the same series of children. The first set of dimensions is termed "endo-oral" and the second "ecto-oral." Hence, we are in a position to offer two sets of observations: (1) the normative dimensional values for the palate and the face; and (2) the possible intercorrelation between these two sets of dimensions. In short, we shall endeavor to clarify the direct question: "Do facial size and configuration really predicate palatal size and form?" To put it simply, "Does an appraisal of face size and configuration lead to a specific idea of palate size and form?"

We should like to point out that the present study is based in every respect on the measurements of the living subject; the endo-oral measurements are taken directly on the palate (not casts thereof), and the ecto-oral measurements are made, at the same time, on the face. We thus are correlating data that we feel to be directly comparable in timing and technique. In other words, both the face and the palate are measured at the same "growth moment" of biologic time.

MATERIAL

The sample of 600 children was studied for the time being from two aspects: (1) chronological, and (2) the dental age (Hellman).† The third aspect of this study, the skeletal age, according to the Todd and Greulich and Pyle Standards (hand x-ray) has been planned for a later date.

METHOD

Since it was not possible to secure impressions and casts of the dentition of each child, for time and financial reasons, it was decided that we should take the measurements directly in the mouth. Therefore, we trained ourselves to obtain the measurements of the palate and the maxillary arch to the utmost

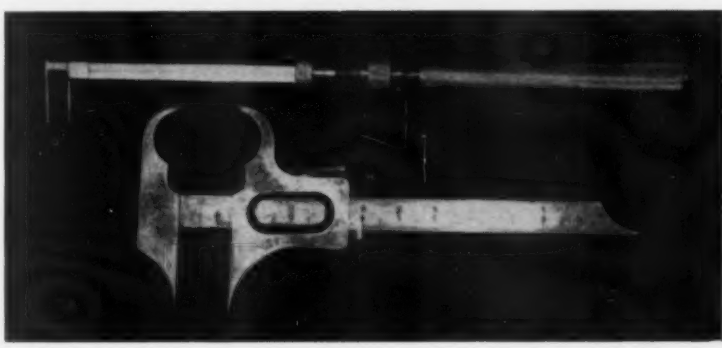

Fig. 1.—Instruments used in endo-oral measurements. Above, instrument used for length measurements; below, instrument used for breadth measurements.

precision possible under the circumstances. The accuracy of this procedure was established by frequent spot-checks, and never was it found that the measurements varied more than 0.5 mm., which we regarded as of no significance.

*Studied at the Philadelphia Center for Research in Child Growth. Dr. Abram Cohen, Director of Dental Services, Department of Education of Philadelphia, aided us in selecting and securing the school sample.

†Chronological age was handled in terms of whole years. Children 6 years 6 months, to 7 years 5 months, were listed as 7 years, and so on.

The palate and maxillary arch widths at various points were secured by means of a Boley gauge adapted for the purpose; the palate length was obtained with the aid of the Evslin bridgemeter, and the arch length was also secured by means of the same (Fig. 1).

The width measurements were taken at the following points:*

Stage III A

c-c		(lingual midpoint mesiodistally)
m_1-m_1	(a)	(midpoint of mesiolingual cusp at neck)
	(b)	(mesial contact point, lingually)
M_1-M_1	(a)	(midpoint of mesiolingual cusp at neck)
	(b)	(lingual groove at the neck)
	(c)	(mesial contact point, lingually)
	(d)	(distal fossa of M_1, distal fossa of M_1)

Stage III B

c-c or C-C or c-C		(lingual midpoint mesiodistally)
Pm_1-Pm_1 or Pm_1-m_1	(a)	(mesiodistal midpoint of the lingual cusp at neck)
	(b)	(mesial contact point, lingually)
M_1-M_1	(a)	(midpoint of mesiolingual cusp at neck)
	(b)	(lingual groove at the neck)
	(c)	(mesial contact point, lingually)
	(d)	(distal fossa of M_1, distal fossa of M_1)

Stages III C and IV A

C-C		(lingual midpoint mesiodistally)
Pm_1-Pm_1	(a)	(mesiodistal midpoint at neck, lingually)
	(b)	(mesial contact point, lingually)
M_1-M_1	(a)	(midpoint of mesiolingual cusp at neck)
	(b)	(lingual groove at the neck)
	(c)	(mesial contact point, lingually)
	(d)	(distal fossa of M_1, distal fossa of M_1)

All the points except the M_1-M_1 (d) were located lingually at the neckline of the teeth because it is presumed that they are the most stable (Fig. 2). There was no pressure whatsoever exerted on the gingival tissue in the process of securing these measurements, and the instrument was always in the closest possible contact with the teeth. Unlike previous investigators, we did not select cusp points or tooth surfaces, as these can be influenced by the varying buccolingual or linguobuccal inclination at which the teeth erupt. The direction of tooth eruption is especially variable during the period of the changing dentition.

The palate length was secured from the point between the two upper central incisors (intradentale superioris linguale) to the posterior nasal spine on the midsagittal plane (Fig. 3).

The arch length was measured from the same point to the intersection of the midsagittal plane with a line connecting the contact point between the first and second molars on the right side with a similar point on the left side (Fig. 4).

In another section of this paper we shall attempt to establish a comparison between the width and length measurements between various Hellman dental stages and those between various chronological ages. It would be opportune at this moment to mention that it was observed that, while the eruption of teeth governed the classification in Hellman's stages, there were prematurely erupted

*Capital letters refer to permanent dentition; lower case letters to deciduous dentition.

permanent canines and premolars, and that the exfoliation of deciduous canines and molars was regarded in many instances according to established chronological standards. Here is where a correlation of the chronological development and skeletal maturation would help us to clear the problem. It seems reasonable to assume that a study of skeletal maturation would have greater importance than chronological age in the evaluation and study of the eruptive time and stages of the various units of the dental arch.

In the series of nearly 600 children that was studied, we limited ourselves to securing the width and length of the palate and the maxillary arch with a view to attempting a correlation between the endo-oral measurements of the palate and the ecto-oral dimensions of the face, particularly the upper face depth and width.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2.—Endo-oral measuring point located on cast of palate.
Fig. 3.—Method of measuring palate depth.
Fig. 4.—Method of measuring arch length.
Fig. 5.—Method of measuring one of the bimolar breadths.

For the purpose of classification we have adopted Angle's classification of malocclusion as modified by Dewey and Anderson, because in our opinion it is the most simple and explicit one available to us from intraoral and arch relationship points of view. The terms used in this paper are defined as follows.

Palate Width.—The palate widths are the measurements secured at neckline or teeth, lingually, from the various points on one side to those of similar teeth diametrically opposite (Fig. 5).

Palate Length.—This measurement is taken from a point between the two central incisors (intradentale superioris linguale) to the posterior nasal spine (Fig. 3).

Arch Length.—The measurement from the same point between the central incisors to the line connecting the contact points between Ml and M2, on the midsagittal plane (Fig. 4).

Occlusion.—In the analysis of our data we shall use the terms "normal occlusion" and "malocclusion." We have followed Dewey and Anderson (ed. 7). Tables I and II give the occlusal distribution in our sample.

TABLE I. DISTRIBUTION OF OCCLUSION: DENTAL AGE

			CLASS I					CLASS II				
		NORMAL	I	II	III	IV	V	DIV. 1	SUB-DIVISION	DIV. 2	SUB-DIVISION	CLASS III
III A	B	84	9	14	5	2	12	28	7	3	1	3
	G	87	12	13	6	2	10	21	7	2	–	2
III B	B	26	9	2	2	5	6	11	3	3	–	3
	G	34	12	5	2	3	5	15	10	3	3	1
III C	B	7	3	–	–	2	1	1	1	–	–	–
	G	15	4	–	–	1	–	4	4	–	1	1
IV A	B	5	2	2	–	1	–	3	3	2	–	–
	G	11	9	–	2	–	1	3	2	2	–	–

TABLE II. DISTRIBUTION OF OCCLUSION: CHRONOLOGICAL AGE

AGE (YEARS)			CLASS I					CLASS II				
		NORMAL	I	II	III	IV	V	DIV. 1	SUBDIVISION	DIV. 2	SUBDIVISION	CLASS III
7	B	23	–	1	–	1	5	6	3	–	–	–
	G	18	1	2	–	–	2	5	2	–	–	2
8	B	15	3	5	2	–	2	8	3	–	–	1
	G	29	5	2	–	–	1	7	–	–	–	–
9	B	26	3	6	2	2	3	11	–	1	1	2
	G	38	4	5	5	3	4	10	5	1	1	–
10	B	22	8	4	3	–	5	8	2	2	–	2
	G	22	7	7	2	1	7	7	4	4	1	1
11	B	17	4	1	–	3	3	6	3	3	–	–
	G	25	6	1	1	1	1	5	5	–	1	1
12	B	19	5	1	–	3	3	6	3	3	–	1
	G	15	14	1	2	1	1	9	7	2	1	–

ENDO-ORAL DIMENSIONS

Presentation of Data.—In the pages that follow we are presenting our data on the basis of Hellman's dental stages and also on chronological age. Each measurement is tabulated first in dental age and then in chronological age.

Arch breadths: Here we shall consider our measurements in logical groups, presenting one dimension at a time, over the dental age range studied.

For bicanine breadth (both c-c and C-C, c-C) the data are as follows when reduced according to dental stages (Table III).

TABLE III

BICANINE DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	172	20.0-28.5	25.4	1.99	183	18.0-30.5	24.0	1.81
III B	65	21.0-33.0	26.3	2.03	82	20.0-32.0	25.4	2.18
III C	16	22.5-31.0	26.3	2.55	26	19.0-29.5	25.7	2.13
IV A	18	21.5-29.0	23.0	2.65	29	22.0-30.0	24.5	2.25

In Table III the c-c dimension is the most frequent in Stages III A and III B. Occasionally, however, C-C was taken in III B stage. In Stages III C and IV A the C-C dimension was characteristic. We notice that this measurement increases between Stages III A and III C about 1 mm. in boys and 1.7 mm. in girls. This increase, though slight, is a measure of the amount of growth between these dental stages.

We notice a decrease in the bicanine breadth from Stage III C to IV A in both sexes, though more marked in males. This may be explained, not as a reversal of a trend, but as due to occlusal instability in a growing child. We have observed that in our series the frequency of malocclusion increases with age.*

When reduced according to chronological age the data for bicanine breadth are as shown in Table IV.

TABLE IV

BICANINE CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	38	21.0-27.5	24.2	1.87	31	18.0-27.0	23.4	1.80
8	38	21.0-30.5	24.6	2.05	42	19.0-28.0	24.1	1.68
9	54	20.0-30.5	25.3	2.04	74	21.0-30.0	24.3	1.84
10	52	21.5-33.0	25.4	1.87	58	20.0-30.0	24.8	2.04
11	34	21.5-32.0	25.9	2.55	45	18.5-29.5	24.9	2.34
12	40	21.0-31.0	25.6	2.08	49	19.0-30.0	25.4	2.05

It is interesting to note that, when reduced according to chronological age, there is a more consistent trend of growth, with greatest gain between 7 and 8 years in girls and 8 and 9 years in boys. (There is usually a female precocity of about a year.) The difference noted previously between Stages III C and IV A is marked (the slight reduction between 11 years and 12 years is negligible). The difference between the two tabulations is due to the much more comprehensive time period of Stage IV A. In our series it covered an age range of 10.6 to 12.5 years.

m_1-m_1 or Pm_1-Pm_1 breadth: This dimension is tabulated according to (1) dental age (Table V) and (2) chronological age (Table VI). As mentioned before, this measurement was secured at two points: (a) the mesiodistal mid-

*As an alternative explanation for decrease in bicanine breadth in Stage IV A we could consider the small sample size as a conditioning factor. Only five out of eighteen children have "normal" occlusions and in these cases the average C-C width was 25 mm. We can resolve this difficulty only by following our series in future years.

point of the lingual cusps of m_1 or Pm_1, at gum level, and (b) the contact point between the canine and the first deciduous molar or first premolar. This was done to obviate, at least in part, the differences of opinion regarding the value of each of these points in the study of arch breadths in a growing child.

TABLE V

M_1-M_1 OR PM_1-PM_1 (A) DENTAL AGE

	BOYS				GIRLS			
DENTAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
III A	149	21.5-35.0	26.9	2.22	143	20.5-30.5	25.8	1.88
III B	54	23.0-32.5	27.2	2.53	63	19.5-35.5	25.6	2.60
III C	20	24.0-32.0	26.7	2.02	28	20.0-32.0	26.6	2.58
IV A	18	22.5-29.0	26.1	1.72	30	21.5-30.5	25.7	2.20

TABLE VI

M_1-M_1 OR PM_1-PM_1 (A) CHRONOLOGICAL AGE

	BOYS				GIRLS			
CHRONOLOGICAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
7	34	21.5-30.0	26.0	1.99	28	22.0-28.0	25.2	1.62
8	34	22.0-30.0	26.7	2.13	37	20.5-29.0	25.4	2.01
9	48	22.0-35.0	27.5	2.33	62	22.5-30.0	26.2	1.81
10*	15	24.0-32.0	27.1	2.18	25	19.5-31.0	25.7	2.59
10**	31	22.0-34.0	27.3	2.39	27	22.5-34.0	26.9	2.54
11*	26	22.5-32.5	26.9	2.96	37	22.0-35.5	26.4	2.43
11**	7	24.0-30.0	27.9	2.17	8	23.0-30.5	26.1	2.33
12	38	23.0-32.0	27.1	2.03	50	20.0-30.0	25.7	2.24

*Pm_1.
**m_1.

Analyzing these tables, we notice in males an increase in the dimension from III A to III B. From III B to IV A there is a consistent decrease, which again seems to point out the instability of the dentition during the transition from deciduous to permanent. In females, however, there is an insignificant decrease from III A to III B. From III B to III C we see a considerable increase, and again a drop of almost 1 mm. from III C to IV A. While this decrease seems to be in keeping with the general trend, the increase at Stage III C is explainable, in our opinion, by the greater number of orthodontically normal girls in the sample.*

When studied according to chronological age, this dimension shows a steady increase from ages 7 to 11 years as long as the m_1 is present on both sides. As soon as the Pm_1 erupts, however, it decreases and this reduction is noticed in some instances from the age of 10 up to 12 years. The same trend exists in girls except at the age of 11 years. This is due to the very small sample (eight) which shows Pm_1 erupted. All this points out that, in our sample, the width of the dental arches is less when Pm_1 erupts than when m_1 is in position on both sides.

*There is another alternative, viz., the growth precocity of the females. In his study of ecto-oral facial growth on the same material (unpublished) Krogman found girls to be, on the average, one dental stage in advance of boys.

TABLE VII

M_1-M_1 OR PM_1-PM_1 (B) DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	165	26.0-39.5	31.7	2.15	161	25.0-34.5	30.6	1.88
III B	56	28.0-39.0	33.2	2.27	63	25.0-38.5	31.7	2.32
III C	19	29.0-36.5	30.0	3.76	28	27.0-36.5	32.9	2.08
IV A	18	29.5-36.5	32.9	1.91	31	28.0-37.0	32.0	1.93

TABLE VIII

M_1-M_1 OR PM_1-PM_1 (B) CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	37	27.0-35.0	31.0	1.95	30	26.5-33.0	30.1	1.79
8	36	27.0-36.5	31.9	2.03	42	25.0-34.0	30.4	2.07
9	50	27.0-39.5	32.3	2.24	66	27.0-35.0	30.9	1.79
10*	15	30.0-38.0	33.1	2.35	25	27.5-35.0	31.2	2.13
10**	38	27.0-38.0	31.7	2.10	35	28.5-35.0	31.0	1.55
11*	26	29.5-39.0	33.2	2.48	37	28.0-38.5	32.6	2.32
11**	9	30.0-35.0	32.9	1.59	7	27.0-34.0	29.8	2.74
12	39	30.0-36.5	33.6	1.77	50	27.0-35.5	32.3	1.97

*Pm_1.
**m_1.

In the m_1-m_1 or Pm_1-Pm_1 (b) dimension (Table VII) we notice an increase from Stage III A to III B. At Stage III C we see a decrease which seems due to the fact that in a sample of fifteen there were eight boys who had malocclusion of Class I, Type IV, or Class II, Div. 1, both of which show constriction in the premolar region. In girls, however, there is a steady increase from III A to III C. Both the sexes show a comparative decrease in this dimension at Stage IV A.

Upon examination of Table VIII we see an increase in this measurement from ages 7 to 9 years, and at the age of 12 years. At the ages of 10 and 11 years, however, the increase maintains itself when the Pm_1 is present. In cases where ml is present we see a decrease. This is explainable by the fact that in the presence of ml the contact between canine and deciduous first molars is greater with consequent reduction of palatal width at this point.

We now turn to a series of tables, all of which are concerned with M_1-M_1 (bimolar) widths. Since there are four measurements in this group, and each has been considered according to both dental age and chronological age, there will be eight tables in sequence. There will be obvious size differences depending on the measuring points selected, but because all the measurements are basically on the same tooth (M_1) the incremental pattern will be very similar.

In the analysis of Tables IX, XI, XIII, and XV, tabulated according to dental age, we note that there is an increase in width from Stage III A to III C. From Stage III C to IV A, we note a decrease in the bimolar width, due to the fact that at this stage our sample had a relatively greater number of cases of malocclusion. The sample was also small and its age range wide.

TABLE IX

M_1-M_1 (A) DENTAL AGE

DENTAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
III A	175	26.5-38.0	32.1	2.47	165	25.0-36.5	31.0	2.26
III B	73	21.5-40.0	32.9	3.10	92	26.0-38.0	31.7	2.62
III C	20	29.0-38.0	33.4	2.46	27	27.0-37.0	32.3	2.76
IV A	18	28.0-37.0	32.8	2.08	31	26.5-35.5	31.9	2.18

TABLE X

M_1-M_1 (A) CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
7	39	25.0-38.0	31.2	2.61	33	25.5-34.0	30.3	2.17
8	39	24.5-36.0	32.3	2.65	44	25.0-35.5	30.5	2.01
9	56	25.0-38.0	32.5	2.59	75	27.0-36.5	31.5	2.28
10	55	28.5-41.0	33.2	2.82	64	27.0-38.0	31.7	2.11
11	36	28.0-39.0	32.8	2.29	48	26.0-36.5	31.7	2.35
12	43	21.5-38.0	33.0	2.86	53	26.5-37.0	31.9	2.58

TABLE XI

M_1-M_1 (B) DENTAL AGE

DENTAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
III A	175	27.0-41.0	34.9	2.41	164	27.5-41.0	33.6	2.37
III B	73	26.5-42.5	35.8	2.95	90	29.0-41.0	34.4	2.36
III C	20	31.0-40.5	36.2	2.28	28	31.0-39.0	32.9	3.47
IV A	18	30.0-40.0	35.4	2.33	29	28.5-39.0	34.3	2.41

TABLE XII

M_1-M_1 (B) CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
7	39	27.0-41.0	34.1	2.68	33	27.5-37.0	33.1	2.21
8	38	29.0-42.0	35.1	2.58	44	28.0-39.0	33.0	2.25
9	56	27.5-41.0	35.2	2.67	75	28.5-41.0	34.3	2.37
10	55	30.5-42.5	35.7	2.61	62	28.5-41.0	34.2	2.24
11	36	30.0-41.0	36.4	2.56	48	29.0-39.0	34.4	2.35
12	43	26.5-40.5	35.8	2.66	51	28.5-39.0	34.6	2.58

TABLE XIII

M_1-M_1 (C) DENTAL AGE

DENTAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
III A	174	32.0-48.0	40.6	2.35	165	33.0-45.0	37.9	2.53
III B	73	30.0-48.0	41.4	3.00	89	33.0-47.0	39.7	2.50
III C	20	37.0-46.0	40.2	2.97	27	36.0-45.5	40.9	2.30
IV A	18	36.0-45.0	41.5	2.18	30	35.0-44.0	39.9	2.20

We may state at this point that in girls there is a definite trend to palatal growth precocity. This is demonstrated in Tables IX and X, and also in Tables XI and XII. The decrease that occurs in boys at Stage IV A shows itself at Stage III C in girls, i.e., the girls are, on the average, one eruptive stage earlier than boys.

TABLE XIV

M_1-M_1 (C) CHRONOLOGICAL AGE

	BOYS				GIRLS			
CHRONOLOGICAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
7	39	34.0-45.0	39.9	2.19	32	33.5-42.0	38.6	1.92
8	39	32.0-46.0	40.6	2.64	44	34.5-43.0	38.8	2.08
9	57	34.0-46.0	41.1	2.44	76	34.0-45.0	39.5	2.41
10	55	36.5-48.0	41.2	2.58	63	35.0-47.0	39.7	2.19
11	36	36.0-48.0	41.4	2.47	48	33.0-45.0	40.0	2.62
12	44	30.0-46.0	41.7	2.82	53	35.0-45.5	40.1	2.41

TABLE XV

M_1-M_1 (D) DENTAL AGE

	BOYS				GIRLS			
DENTAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
III A	158	38.5-53.5	45.5	2.37	151	33.0-50.0	44.0	2.55
III B	64	38.0-52.5	46.5	2.86	85	39.0-51.0	44.6	2.55
III C	14	41.0-50.0	46.5	2.32	26	40.0-50.0	45.5	2.55
IV A	18	41.0-50.0	46.0	2.30	27	39.0-48.0	44.6	2.25

TABLE XVI

M_1-M_1 (D) CHRONOLOGICAL AGE

	BOYS				GIRLS			
CHRONOLOGICAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
7	36	38.5-50.0	44.5	2.39	29	38.0-46.5	43.3	1.99
8	36	42.0-49.0	45.6	1.91	41	38.5-48.0	43.4	2.37
9	53	38.5-52.0	45.9	2.46	74	40.0-50.0	44.6	2.63
10	55	41.0-53.5	46.3	2.71	59	40.0-51.5	44.7	2.19
11	34	41.0-51.0	45.9	2.40	41	39.0-50.0	44.8	2.35
12	40	38.0-51.0	46.7	2.59	48	39.0-51.0	45.0	2.55

We may conclude, therefore, that Hellman's dental stages cannot be depended on exclusively for an evaluation of the development of the arches, because they are based entirely on the eruptive stages of teeth. In other words, a child may have prematurely erupted teeth and be placed in a higher age category, thereby suffering in comparison in bone growth and development, as found in the child's age peers. Stage IV A shows this in a very graphic way because, according to Hellman, the average age for this stage is 14.89 years for boys and 16 years for girls. This is the reverse of what we have found in our sample. Furthermore, Stage IV A in our sample has been found as

early as 10.6 years and it is presumed could last until the age of 17 or 18 years, which gives us a possible age range of roughly seven years.*

Arch lengths: Our analysis discussed previously gives us some idea of the growth pattern of the width of palatal arch at Hellman Stages III A to IV A and chronological ages 7 to 12 years in transverse or breadth dimensions. We now shall observe the pattern of growth in palatal length and arch length as discrete units.

TABLE XVII

PALATE LENGTH — DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	170	38.0-51.0	42.0	2.16	163	33.5-46.5	40.7	2.11
III B	70	35.0-53.0	43.3	3.28	90	36.0-48.0	41.9	2.40
III C	16	37.0-49.0	43.6	2.96	28	40.0-49.0	43.5	2.21
IV A	18	41.0-54.0	45.9	3.24	29	38.5-49.0	44.8	3.04

TABLE XVIII

PALATE LENGTH — CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	39	38.0-47.0	41.4	1.93	32	37.0-45.0	40.8	2.06
8	39	39.0-46.0	42.3	2.10	44	36.0-45.0	40.6	2.05
9	56	35.0-55.0	42.5	2.50	76	34.5-47.5	41.1	2.22
10	55	37.0-49.0	42.3	2.44	64	36.5-47.0	41.5	2.15
11	36	40.0-50.0	44.0	2.35	46	33.5-49.0	42.5	3.21
12	43	36.0-54.0	45.3	3.80	52	37.0-52.0	43.7	2.83

In Table XVII it is interesting to note that the palate length shows very little growth from Stage III A to III B. We do notice, though, a considerable amount of dimensional increase at Stages III C and IV A. We can deduce, therefore, that the palate is moved anteriorly by posterior deposition of bone to accommodate second and third molars. The same trend is clear for chronological age as seen in Table XVIII. Up to the age of 10 years the increase is within 0.5 mm. At 11 and 12 years, however, we notice an increase of as much as 1.7 mm. in boys and 1.2 mm. in girls.

Tables XIX and XX offer further proof of this observation.

We notice that in these tables there is practically no dimensional change in arch length. In other words, the arch length from the distal contact point of M_1 to intradentale superioris linguale remains unchanged in the age range under discussion. To put it concretely, once M_1 is erupted there is no increase in palate length anterior to M_1.

Another fact that is noteworthy in this study is that the bimolar width in Tables XIII and XIV at Stages III A and III B is within 2.0 mm. of palate length shown in Tables XVII and XVIII. At Stages III C and IV A, how-

*The comparison has been made with Hellman norms since, up to the present, we have used them. We are, at the Growth Center, in the process of revising the III A to IV A average age categories. When this is done the present data will be directly comparable.

TABLE XIX

ARCH LENGTH DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	153	31.0-44.0	38.4	2.12	144	31.0-44.0	37.1	2.09
III B	58	28.0-43.0	38.5	2.83	75	31.0-43.0	37.2	2.48
III C	13	35.0-42.0	38.2	2.18	25	34.5-42.0	38.1	1.68
IV A	18	34.0-43.0	38.1	1.99	27	31.0-43.5	37.6	2.85

TABLE XX

ARCH LENGTH CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	32	35.0-43.0	38.1	1.96	29	32.0-41.5	37.1	2.31
8	34	34.0-43.0	38.8	2.10	41	31.0-41.0	36.8	2.06
9	53	33.0-44.0	38.4	1.89	67	32.0-44.0	37.5	1.89
10	53	31.0-42.0	38.0	2.41	51	32.0-43.0	37.2	2.09
11	27	32.5-42.0	38.4	2.74	40	31.0-42.0	36.7	2.40
12	40	28.0-43.0	38.7	2.75	49	32.0-43.5	37.7	2.70

ever, the difference between the palate length and palate width at the contact point of M_1 with Pm_2, is roughly as much as 4.5 mm. in boys and 5.0 mm. in girls. This affirms our statement that increase in palate length is by posterior addition.

Before turning to an analysis and comparison of ecto-oral dimensions, we may summarize up to this point as follows:

(1) The bicanine width shows an increase between Dental Stages III A and III B. According to chronological age, this occurs between 7 and 8 years in girls, and between 8 and 9 years in boys.

(2) Between the Dental Stages III C and IV A there is a decrease in this dimension caused, in our opinion, by the instability of changing dentition and the greater number of malocclusions in our sample. Chronologically this decrease, although negligible, is noticeable between 11 and 12 years.

(3) The ml-ml breadth similarly shows an increase from Stage III A to III B and a decrease from III C to IV A. Chronologically, this dimension shows a steady increase from 7 to 11 years as long as ml is present. When Pml erupts, however, there is a decrease in this dimension, corresponding to chronological ages 10 to 12.

(4) The bimolar breadths show an increase from Stage III A to III C. At Stage IV A the decrease is probably attributable to the smallness of our sample and the relatively greater number of cases of malocclusion, rather than to a reverse trend.

(5) The palate length increases by posterior deposition of bone as soon as M2 shows signs of beginning eruption.

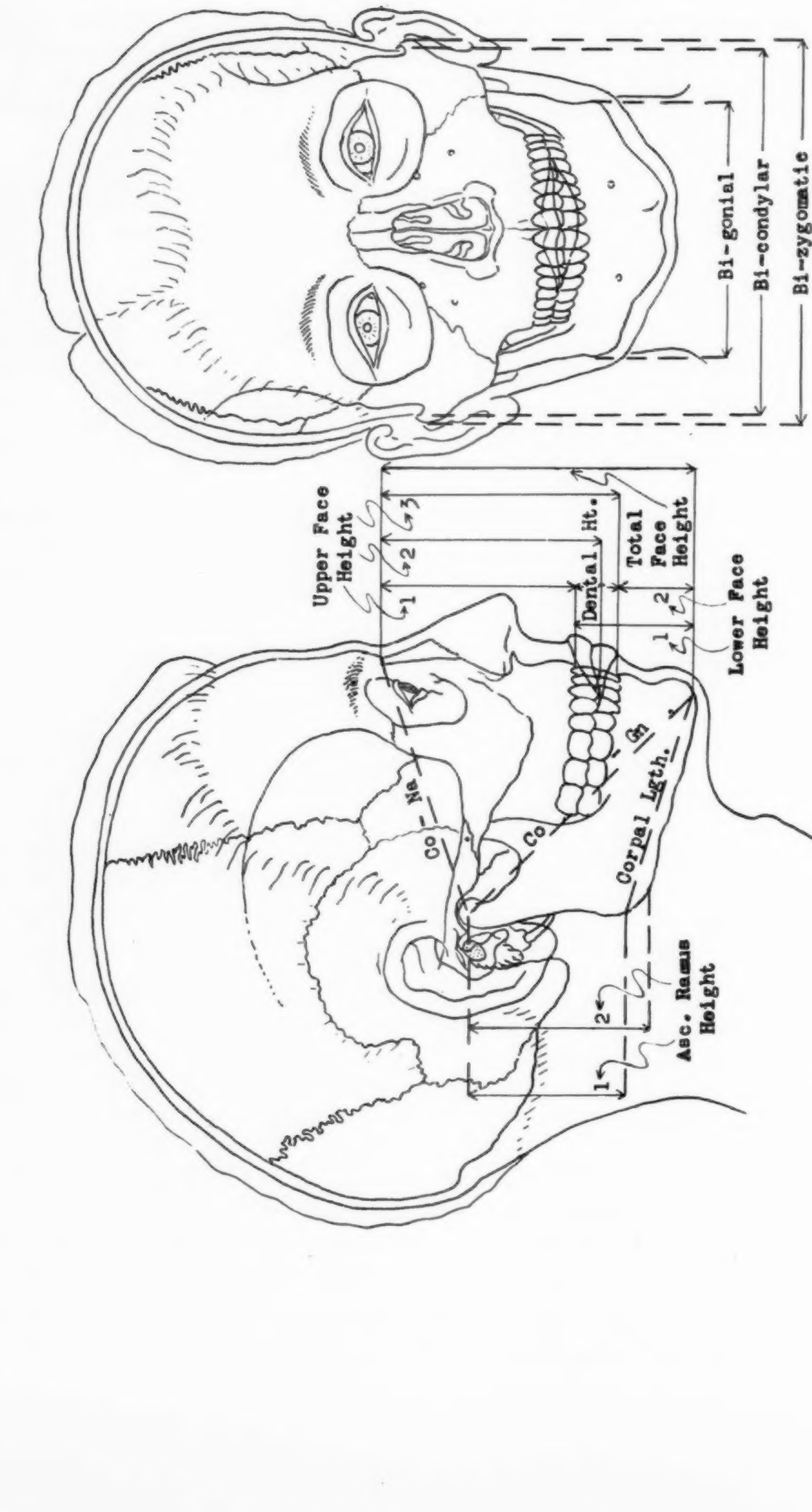

Fig. 6.—Facial measurements. *A*, heights and mandibular measurements; *B*, breadths.

(6) There is no change in the arch length anterior to M_1. More specifically, there is no change in length anterior to M_1, once this tooth has erupted.

ECTO-ORAL FACIAL DIMENSIONS*

Our endo-oral measurements were confined to the palate. In order to establish any possible correlation between them and ecto-oral measurements, we felt that only the following were comparable:

Face breadths (Fig. 6, *B*): Bizygomatic
Bicondylar (closed)

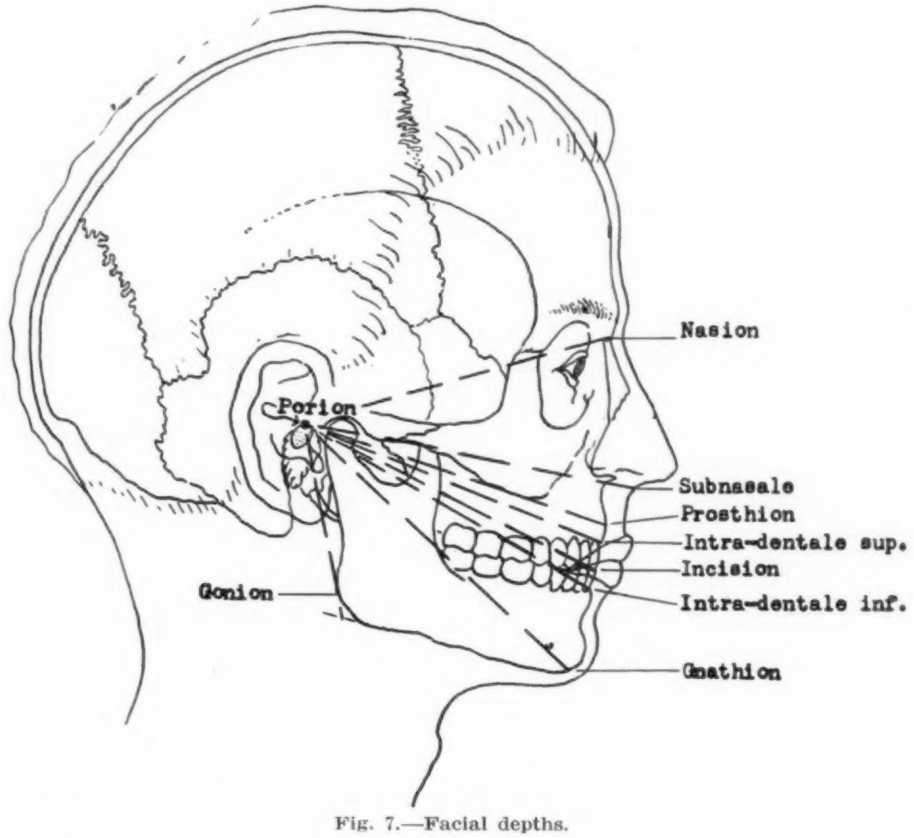

Fig. 7.—Facial depths.

Face depths of the maxillary structure (Fig. 7): Porion-Subnasale
Porion-Prosthion
Porion-Intradentale Superioris (labiale)

We shall tabulate them in the same manner as the endo-oral dimensions.

An analysis of Tables XXI and XXII shows a considerable increase in boys. This increase occurs in girls continuously from Stage III A to III B to III C. Chronologically these changes are noticed in boys from 7 to 8 years,

*These data are from the files of the Growth Center.

TABLE XXI

BIZYGOMATIC DENTAL AGE

DENTAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
III A	176	104.0-134.0	118.5	6.47	169	103.0-133.0	117.2	5.08
III B	65	114.0-136.0	124.5	5.00	84	110.0-133.0	120.7	4.69
III C	16	119.0-135.0	125.8	4.89	27	114.0-133.0	124.0	4.51
IV A	19	120.0-137.0	128.2	4.15	30	112.0-138.0	123.5	6.05

TABLE XXII

BIZYGOMATIC CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	BOYS RANGE	BOYS MEAN	BOYS S. D.	GIRLS NO.	GIRLS RANGE	GIRLS MEAN	GIRLS S. D.
7	39	105.0-126.0	115.7	5.03	43	104.0-131.0	112.8	4.94
8	42	109.0-132.0	120.6	4.94	46	103.0-123.0	115.6	4.77
9	59	113.0-134.0	121.6	4.76	75	110.0-133.0	119.2	4.84
10	59	111.0-136.0	122.9	5.03	66	107.0-133.0	120.0	5.03
11	37	117.0-137.0	125.4	4.98	42	110.0-130.0	121.0	4.78
12	43	116.0-135.0	126.3	4.85	55	112.0-138.0	123.6	4.46

and again from 10 to 11 years. In girls they are evident from 7 to 8, 8 to 9, and again from 11 to 12 years. All this points out the precocity of growth and development in girls by one to two years. We shall have further and more definitive evidence of this as our serial study progresses.

The bicondylar breadth, however, shows a considerable increase from Stage III A to III B, and from III B to III C in boys and girls. At Stage IV A it continues to increase slightly in boys, while in girls it shows a decrease which is within experimental error of measurement. The chronological analysis shows a considerable rate of increase in boys between 7 and 8 years, slows down between 8 and 10 years, and shows another acceleration between 10 and 11 years, an increment which remains steady at 12 years. In girls the accelerated rate of growth is evident between 8 and 9 years, and 10 and 11 years. Between 9 and 10 and 11 to 12 it seems to be steady.

We conclude, therefore, that in boys the growth takes place in alternate increments, while it is almost continuous in girls. In other words, the boys grow faster between 7 and 8, and 10 and 11 years of age, while the girls maintain a steady yearly rate of growth from 8 to 11 years.

Face Depths.—Face depths (ecto-oral) may bear a relationship with palate length and arch length. In order to analyze this, we shall tabulate the depth dimensions of the maxillary structure in the same manner in which we dealt with the other dimensions, i.e., according to (1) dental stages and (2) chronological age.

The study of Tables XXV, XXVII, and XXIX reveals an accelerated rate of growth in boys from Stage III A to III B, and from III B to III C. This rate slows down from Stage III C to IV A. The only exception to this is the porion-subnasale dimension in which the change from III A to III B is negligible.

TABLE XXIII

BICONDYLAR (CLOSED) DENTAL AGE

	BOYS				GIRLS			
DENTAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
III A	178	94.0-129.0	109.4	4.99	167	91.0-128.0	106.8	6.29
III B	65	103.0-124.0	113.1	4.84	83	96.0-126.0	109.1	6.39
III C	16	104.0-125.0	115.4	5.76	27	102.0-119.0	111.0	5.03
IV A	19	108.0-126.0	116.4	4.17	30	100.0-122.0	110.2	7.28

TABLE XXIV

BICONDYLAR (CLOSED) CHRONOLOGICAL AGE

	BOYS				GIRLS			
CHRONOLOGICAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
7	39	94.0-118.0	106.2	5.49	43	91.0-128.0	103.3	6.62
8	42	99.0-129.0	110.2	5.64	46	93.0-112.0	104.8	5.13
9	59	100.0-122.0	110.4	5.04	74	99.0-121.0	108.2	4.63
10	59	100.0-124.0	111.4	5.08	66	93.0-126.0	108.8	5.67
11	37	104.0-126.0	114.1	5.01	42	96.0-121.0	110.5	5.83
12	43	102.0-125.0	114.4	4.98	55	101.0-132.0	110.6	6.26

In females this accelerated increment is evident from Stage III A to III B, and from III B to III C. From Stage III C to IV A we notice a decrease of less than 1 mm. Exceptions to this are again present in porion-subnasale dimension; from Stage III B to III C there is a decrease of 0.9 mm. This will have to be checked when our sample sizes of III C and IV A are larger.

Chronologically these dimensions (Tables XXVI, XXVIII, and XXX) follow the same trend of growth as the face breadths in boys, i.e., an accelerated rate of growth between 7 and 8 years, and again between 10 and 11 years. In

TABLE XXV

PORION-SUBNASALE DENTAL AGE

	BOYS				GIRLS			
DENTAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
III A	172	74.0-98.0	85.2	4.52	167	73.0-95.0	82.8	4.53
III B	65	78.0-96.0	85.6	3.81	81	74.0-97.0	86.8	4.78
III C	15	84.0-94.0	88.7	2.84	27	81.0-95.0	85.9	5.29
IV A	19	83.0-97.0	90.1	3.94	29	79.0-98.0	87.3	5.00

TABLE XXVI

PORION-SUBNASALE CHRONOLOGICAL AGE

	BOYS				GIRLS			
CHRONOLOGICAL AGE	NO.	RANGE	MEAN	S. D.	NO.	RANGE	MEAN	S. D.
7	38	75.0-95.0	81.0	5.66	41	68.0-92.0	82.3	5.63
8	42	78.0-95.0	85.9	4.39	46	73.0-89.0	82.2	3.98
9	59	78.0-93.0	84.7	3.60	75	73.0-92.0	82.7	4.16
10	59	74.0-96.0	85.7	4.26	64	73.0-97.0	85.0	5.04
11	37	79.0-97.0	87.6	3.63	41	74.0-98.0	87.2	5.62
12	42	78.0-97.0	87.4	4.39	55	80.0-95.0	87.0	4.25

girls this accelerated rate of growth is continuous from 9 to 10, and from 10 to 11 years. It follows the same pattern as the bicondylar breadth: a constant rate of growth with relative accelerations from 9 to 10, and from 10 to 11 years.

TABLE XXVII

PORION-PROSTHION — DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	175	75.0-95.0	84.6	4.30	172	70.0-94.0	82.4	4.64
III B	66	78.0-98.0	86.5	4.31	81	75.0-95.0	85.5	4.51
III C	15	81.0-96.0	88.1	3.78	27	82.0-96.0	88.0	3.53
IV A	19	84.0-98.0	89.5	3.76	29	81.0-98.0	87.4	4.25

TABLE XXVIII

PORION-PROSTHION — CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	38	74.0-90.0	82.4	3.60	41	69.0-92.0	80.2	5.07
8	42	75.0-95.0	85.3	4.55	46	71.0-92.0	81.6	4.43
9	59	78.0-94.0	84.7	3.70	75	71.0-93.0	82.4	4.09
10	58	75.0-96.0	85.7	4.37	64	75.0-94.0	95.2	4.69
11	37	80.0-95.0	87.5	3.61	41	75.0-98.0	87.1	5.02
12	42	78.0-98.0	88.6	4.49	55	81.0-94.0	86.9	3.49

TABLE XXIX

PORION-INTRADENTALE SUPERIORIS LABIALE — DENTAL AGE

DENTAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
III A	175	75.0-97.0	85.2	4.38	169	70.0-94.0	83.9	4.71
III B	65	77.0-98.0	87.1	4.17	81	75.0-97.0	86.2	4.63
III C	15	82.0-97.0	89.1	4.07	27	83.0-97.0	89.2	3.58
IV A	19	85.0-99.0	90.4	3.95	29	80.0-99.0	88.3	4.31

TABLE XXX

PORION-INTRADENTALE SUPERIORIS LABIALE — CHRONOLOGICAL AGE

CHRONOLOGICAL AGE	BOYS NO.	RANGE	MEAN	S. D.	GIRLS NO.	RANGE	MEAN	S. D.
7	37	74.0-91.0	82.6	3.74	41	69.0-90.0	80.4	4.89
8	42	75.0-96.0	85.7	4.59	46	71.0-92.0	81.9	4.42
9	59	78.0-95.0	85.2	3.86	75	70.0-93.0	82.9	4.30
10	58	76.0-92.0	86.3	4.49	64	75.0-95.0	85.8	4.64
11	37	81.0-96.0	88.3	3.55	41	75.0-99.0	87.8	5.35
12	42	77.0-99.0	89.2	4.80	55	82.0-96.0	87.8	3.51

Summarizing our analysis of the ecto-oral dimensions, we may conclude as follows:

(1) On the basis of Hellman's dental stages, the bizygomatic breadth shows an accelerated rate of growth at two different times in boys, with a uniform

rate in girls. On the basis of chronological age, in the age range of our sample, we notice two periods (7 to 8 and 10 to 11 years) of accelerated growth in boys and three (7 to 8, 8 to 9, and 11 to 12 years) in girls.

(2) In the bicondylar (closed) breadths both boys and girls show a similar trend of growth according to dental stages. The chronological age analysis shows that there are accelerated periods of growth in boys which are similar in time to those for dental stages. In girls the growth is uniform from 8 to 11 years.

(3) The facial depths follow the growth trend and pattern of the bicondylar breadth in both boys and girls.

DISCUSSION

The data of our problem have raised three main points: (1) The relation between chronological age and dental age categories; (2) the actual amounts of growth of the palate and face during the age periods covered; and (3) the fundamental relation between endo-oral and ecto-oral growth in both dimension and time. We shall deal with them in that sequence.

1. When the data are grouped according to chronological age the passage of time is calendric rather than biologic. More explicitly, the unit of time, a year, is constant for every individual and has little or no reference to the basic growth impulse that may, and does, show a variation linked with individual progress toward maturity.

The calcification and eruption of the teeth are, as Krogman[15] has pointed out, maturity indices. The process of the development of the deciduous and permanent dentition is one of maturation. The completion of the deciduous and permanent dentitions is the attainment of maturity with reference to the dental growth pattern.

Therefore, the difference between the categories of chronological and dental ages is an important one, inasmuch as the dental age is more nearly related to a maturity indicator in each growing child. We feel, therefore, that grouping by dental age is not an artificial category; rather, it is the chronological age category that is arbitrary.

A year-by-year grouping of the data is bound to give an impression of greater regularity in growth. The total amount of growth (in this study between seven and twelve years) is divided into six more or less equal and even units. Here time has little or no regard for biology, expect that growth proceeds through the passage of years.

The dental age is related, by its very definition, to a category established upon a biologic foundation, i.e., tooth eruption is a reflection of growth biology. Hence, we have introduced a variable age category, based upon a growth response of known variability. Hurme[13] has shown, for instance, that the second permanent molar erupts in boys, on the average, at 12.12 years, with "early" at 10.75 years and "late" at 13.5 years. Since Dental Stage IV A is defined

by the eruption of this tooth, there is an obvious age range of 2.75 years; in other words, an age category (at this stage) which is almost three times longer than that on an annual basis. Furthermore, Stage IV A lasts until well beyond 16 years of age.

It is quite obvious that the dental age unit is intrinsically more variable than the chronological age unit, and defensibly so. Another factor that merits consideration is normal occlusion versus malocclusion. In a category more directly related to tooth eruption, the effect of maleruption or malposition, or faulty tooth-bone relationship or deviant interdental (or maxillomandibular) growth is greater dimensionally. This assumes that in palatal dimensions, at least, the effects of malocclusion will be evident either in size (dimension) or in proportion (relation of one dimension to another).

In dental age, therefore, we have to cope with variability of two sorts: (1) the duration of the time unit by itself, and (2) the effect of malocclusion upon dimensionality or proportionality. It may be argued that these two factors are present in the chronological time unit as well. To a certain extent this is true, but in this time unit the effect is diffused, while in the dental age unit it is concentrated. We feel that malocclusion is linked more with the dynamics of the developing dentition than it is with mere age itself.

We have, of course, a residual factor of variability in our present data: our dental age categories III C and IV A show inadequate numbers, especially in boys. It is possible that in time, as we follow the III A's and III B's into III C and IV A, we may resolve some of our present difficulties, on both numerical and normal occlusion versus malocclusion bases, i.e., we have reasons to hope that we shall have more normal occlusions in our later categories.

This study is our first effort at comparing the grouping of data by two time units: chronological (annual) and biologic (dental). We feel that both of the two methods elucidate growth progress in the palate and face, but more strongly that the latter method is more meaningful in terms of dentofacial growth dynamics. In the last analysis tooth eruption and facial (bone) growth both are aspects of a basic biologic growth impulse in the organism. Tooth and bone are, in our opinion, more related to each other than either of them is to time per se.

2. The actual total amounts of growth in the palate and face in the data of this study are shown in Table XXXI.

In this table we have given the total amount of growth (change in average size) in each palatal breadth and length dimension according to two categories: dental age, III A to IV A; chronological age, 7 to 12 years. Furthermore, we have shown the total change as either a plus (increase in size) or minus (decrease in size).

Several facts emerge at once: (1) the change is mostly plus, and greater for chronological age than for dental age, averaging about 2 mm. for the former and 1 mm. for the latter; (2) the transverse dimensions of the anterior part of the arch (c-c, C-C, or C-c and m_1-m_1, Pm_1-Pm_1, or Pm_1-m_1) show a decrease

TABLE XXXI. TOTAL DIMENSIONAL GROWTH IN THIS SERIES

DIMENSION		BOYS		GIRLS	
		DENTAL AGE III A TO IV A	CHRON. AGE 7 TO 12 YEARS	DENTAL AGE III A TO IV A	CHRON. AGE 7 TO 12 YEARS
Bicanine		-2.4	+1.4	+0.5	+2.0
m_1-m_1 or	(a)	-0.8	+1.1	-0.1	+0.5
Pm_1-Pm_1	(b)	+1.2	+2.6	+1.4	+2.2
M_1-M_1	(a)	+0.7	+1.8	+0.9	+1.6
	(b)	+0.5	+1.7	+0.7	+1.5
	(c)	+0.9	+1.8	+2.0	+1.5
	(d)	+0.5	+2.2	+0.6	+1.7
Palate length		+3.9	+3.9	+4.1	+2.9
Arch length		-0.3	+0.6	+0.5	+0.6

when averaged by dental age, or are considerably smaller than for chronological age; (3) the growth in palate length shows the greatest change, consistently an increase; (4) the total change in palatal breadth after eruption of M_1 (between the eruption of M_1 and M_2, which is III A to IV A) is not great and there are little or no sex differences; (5) arch length shows no significant change after eruption of M_1. This may be interpreted that gain in palate length during III A to IV A period is posterior to M_1 or, more positively, that after the eruption of M_1 there is no increase in palate length anterior to M_1.

We now shall explain the decreases. They occur only when the data are averaged according to dental age. This affirms our conclusion that dental age, rather than chronological age, reflects the true biologic nature of faciodental growth changes. The decrease in the transverse breadth at c, m_1, or C, Pm_1 level is due, we are convinced, to a frequency of cases of malocclusion in our IV A group. It is precisely these deviants, mostly Class II, Division 1, or Class I, Types II or IV cases, that affect the averages at IV A and give a decrease that is reflected in the over-all summation.*

This, in our opinion, is an important observation, in that it reflects the ease with which "averages" can be thrown out of line by relatively slight occlusal deviations. This is especially true when the amounts of total change (normally an increase) are of the order of only 2 to 3 millimeters, as in the case of the present material. Though relatively small in structure, the palatal arch, in its breadth dimensions, evidently is a very sensitive recorder of the over-all growth balance of the dentoalveolar complex.

3. Now let us observe the growth changes in the various ecto-oral dimensions we have chosen for comparison (Table XXXII).

First of all, the changes are all positive, or an increase; second, increase in breadth dimensions is, with but one exception, greater than the increase in depth; third, average increases are slightly greater for chronological age than for dental age.

It certainly is not possible to say whether or not palatal breadth increase and depth increase are reflected in these outer facial dimensions. Let us assume,

*We are checking this conclusion by regrouping all our data by sex and occlusal classification and reducing them in both dental age and chronological age categories.

TABLE XXXII

DIMENSION	BOYS DENTAL AGE III A TO IV A	BOYS CHRON. AGE 7 TO 12 YEARS	GIRLS DENTAL AGE III A TO IV A	GIRLS CHRON. AGE 7 TO 12 YEARS
Depths				
Porion-subnasale	+4.9	+6.4	+4.5	+7.7
Porion-prosthion	+5.3	+6.2	+5.0	+6.7
Porion-int.sup.lab.	+5.2	+6.6	+4.4	+7.4
Breadths				
Bizygomatic	+9.7	+10.6	+6.3	+10.8
Bicondylar (closed)	+7.0	+8.2	+3.4	+7.3

however, that they were. At best the palate breadths could contribute about 2 mm., and palate length about 4 mm. This leaves a net ecto-oral gain of 1 to 2 mm. in depths and 6 to 7 mm. in breadths. In other words, it seems that ecto-oral depths are more related to palate length than ecto-oral breadths are to palate breadth. To say it concisely, mesiodistal relationships in the face are more prognostic of dento-palatofacial relationships than transverse relationships.

The preceding conclusion goes far to validate the lateral cephalometric roentgenographic approach in the interpretation of dentofacial analysis. In the lateral view the relation between facial structure and dentopalatal alignment is a much more intimate one. The relation is not perfect and probably is not precise, but it is sufficient to relate endo-oral palate length and ecto-oral facial depth on a functional and possibly reciprocal basis.

SUMMARY

1. A sample of 600 Philadelphia public school children, aged 7 to 12 years, from the average middle class was selected for this study. It was as representative as possible from health, socio-economic, and ethnic points of view. These children are being studied serially, on an annual basis, at the Philadelphia Center for Research in Child Growth.

2. The endo-oral measurements were secured directly on the palate of each subject and at the same time as the ecto-oral or facial measurements, to eliminate any possible age discrepancies.

3. The endo-oral measurements comprise seven breadth measurements and two length measurements of the palate. The ecto-oral measurements comprise two breadth measurements and three depth measurements. All data have been reduced both according to dental stages (Hellman) and chronological age.

4. The analysis of the endo-oral data led to the following conclusions:

A. The bicanine width shows an increase between Dental Stages III A and III B. According to chronological age this occurs between 7 and 8 years in girls, and between 8 and 9 years in boys.

B. Between the Dental Stages III C and IV A there is a decrease in this dimension caused, in our opinion, by the instability of changing

dentition and the greater number of malocclusions in our sample. Chronologically this decrease, though negligible, is noticeable between 11 and 12 years.

C. The m_1-m_1 breadth similarly shows an increase from Stage III A to III B and a decrease from III C to IV A. Chronologically, this dimension shows a steady increase from 7 to 11 years as long as m_1 is present. When Pm_1 erupts, however, there is a decrease in this dimension, corresponding to chronological ages 10 to 12.

D. The bimolar breadths show an increase from Stage III A to III C. At Stage IV A the decrease is probably attributable to the smallness of our sample and the relatively greater number of cases of malocclusion, rather than to a reverse trend.

E. The palate length increases by posterior deposition of bone as soon as M2 shows signs of beginning eruption.

F. There is no change in the arch length anterior to M_1. More specifically, there is no change in length anterior to M_1, once this tooth has erupted.

5. The analysis of the ecto-oral data led to the following conclusions:

A. On the basis of Hellman's dental stages, the bizygomatic breadth shows an accelerated rate of growth at two different times in boys, with a uniform rate in girls. On the basis of chronological age, in the age range of our sample, we notice two periods (7 to 8 and 10 to 11 years) of accelerated growth in boys and three (7 to 8, 8 to 9, and 11 to 12 years) in girls.

B. In the bicondylar (closed) breadths both boys and girls show a similar trend of growth according to dental stages. The chronological age analysis shows that there are accelerated periods of growth in boys which are similar in time to those of dental stages. In girls the growth is uniform from 8 to 11 years.

C. The facial depths follow the growth trend and pattern of the bicondylar breadth in both boys and girls.

6. When the endo-oral and the ecto-oral dimensions are considered functionally, it is concluded that mesiodistal relationships in the face are more prognostic of dento-palatofacial relationships than are transverse relationships. This conclusion, in our opinion, goes far to validate the lateral cephalometric roentgenographic approach in the interpretation of dentofacial analysis.

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POWER STORAGE AND DELIVERY IN ORTHODONTIC APPLIANCES

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FORCE is the agency by means of which orthodontic tooth movement is accomplished. Because, according to the fundamental law of physics, "for every action there is an equal and opposite reaction," desired tooth movement is accomplished by the employment of sufficient resistance to this "equal and opposite reaction" to meet the specific need. This resistance is called anchorage.

Orthodontic appliances are the means of storing and delivering the force which is exerted between the anchorage and the teeth to be moved. Power may be stored and force exerted by them in greatly varying degrees regarding amount, direction, time, distance, and constancy. This variance is dependent upon both the materials of which the appliances are constructed and upon their design.

It is the purpose of this paper to discuss the last two factors in the hope that by doing so we may accomplish a better understanding of these appliances and wherein, if at all, they fall short of the theoretical ideals we have in mind for them.

I have stated that orthodontic appliances are the agency by means of which force is exerted between teeth themselves, and between teeth and other means of resistance, for the purpose of bringing about desired tooth movement. That force is something neither created nor lost is a fundamental law of physics. Let us therefore see where the force that is utilized to move teeth comes from and what becomes of it.

In very rare instances power is generated within the appliance itself by such means as the shrinking or swelling of the material of which the appliance is made (grass-lines). In others, biting stress is directed toward the teeth to be moved in such manner that desired tooth movement is accomplished (bite ridges and inclined planes). The forces that result from the activities of the tongue, lips, and cheeks are sometimes harness, transmitted and delivered as desired (muscle exercises). In the great majority of cases force from the hands of the operator or the patient is stored in the appliance as power, from which it is transmitted to the teeth. Sometimes all of this power is delivered in a short space of time and over a very short distance, and sometimes it is partially stored by the appliance and delivered to the teeth over a longer period of time and over a greater distance, the amount of force possibly being constant over the entire time and distance, but more likely gradually diminishing in amount.

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The ability of an appliance to store power and then to deliver it back to the teeth is generally dependent upon the elasticity of the material used. The distance through which this elasticity acts is also dependent upon the design of the mechanism. In most instances the length of time during which this power is being distributed is dependent upon the resistance of the teeth involved, the amount of force applied, and the distance through which it will act. It is also dependent upon the tissue reactions of the individual patient.

Let us consider a typical, simple, modern appliance and determine what becomes of the energy that has been stored in it. For example, let us consider the expansion arch E. Let it be attached to anchor bands on the first molars. By means of a ligature a central incisor is tied to the arch, with force applied. Force is exerted anteriorly upon the central incisor and posteriorly upon the molars which act as resistance or anchorage. Because there is a limited amount of free movement permitted, the teeth by the manner of their natural attachments, pressure applied to the incisor would result in its immediate movement to the limit of the range of the free movement permitted. Likewise, the anchor teeth would move in the opposite direction, to the limit of the free movement permitted them. As soon as all of this "slack" is taken up, the resistance of the alveolar bone would be brought to bear and the remaining force stored in the arch would continue to be exerted in opposite directions. When additional force is applied by the ligature in question, the arch can approach the incisor only by becoming distorted. Because the arch is elastic within limits, it has power to return to its original form. By virtue of this ability to return to the original form, power is stored and delivered.

In this state of equilibrium force is being exerted by the appliance on the teeth continuously in a constant amount. Because the teeth are vital organs, invested in vital tissue, reaction in the living tissue soon takes place in such a way that tooth movement is permitted. By the movement of the tooth, some of the distortion in the appliance is released, thus releasing some of the stored power. In this manner equilibrium remains constant until all of the power is dissipated.

Ideally this would be true; practically it is far from being true. During this time the teeth and the appliance have been subjected to an almost constant battery of forces from the cheeks, lips, and tongue and, particularly, from the forces of occlusion. The delivery of force from the appliance is therefore far from being constant.

Thus we see that the ability to store power in an appliance must be countered by an equally necessary ability to resist undesirable distortion, which would store and deliver inconstant and undesirable force. In other words a compromise must be made between extremely light appliances which possess a high degree of elasticity and store power well, and heavy, nonyielding appliances which possess a high degree of stability and resist undesirable environmental forces to a sufficient degree.

The demand for stability in an appliance varies greatly in various areas of the mouth. As a matter of fact, the demands for stability in an appliance

vary greatly even on different areas of a tooth. Near the cutting edge or masticating surface, the stresses of mastication are great. Near the gingiva these stresses are materially minimized. Apically to the gingival border they diminish to the vanishing point. Appliances whose energizing members (generally arch wire) are placed close to the occlusal surfaces must meet the requirements of stability to a high degree. Those with these members placed well gingivally permit of greater elasticity and less stability.

Great variances exist in the anterior, middle, and extreme posterior portions of the mouth. Anteriorly, food is incised or chunked. Even though the mandible is incapable of closing with as much force in the anterior part of the mouth as in the posterior part, great stress is exerted upon the appliance in this region because of the large solid masses that it is called upon to break up. It is in the first molar areas that the major portion of mastication is done. Even though the food comes to this area wholly incised, or in small chunks, comparatively great force is required here to masticate it into small bits. Both theory and clinical evidence reveal the fact that the greatest need for stability in the arch wire exists here, for here it is that the arch wire is most often bent or fractured by mastication.

Study of, and experience in, the relative needs for stability in maxillary and mandibular portions of the mouth would indicate that the mandibular portion presents the greater need for this quality.

One of the most important factors contributing to lack of stability is the length of unsupported span of the arch wire. If the arch wire is supported by every tooth along its way it may be very light and very elastic. If, on the other hand, long empty spaces exist, the laws of leverage are brought to bear on these spans in such a way that great increase in cross section of the arch wire is necessary to resist the forces which it is called upon to withstand.

Because of the many and varying demands for stability in an appliance, there probably can never be one devised which will perfectly meet all demands made upon it. The perfect appliance would have to meet all demands of stress and still have a sufficient margin of safety adequately to meet extreme demands without serious interference with the requirements of elasticity.

What, then, are the needs for elasticity? This immediately presents itself as a variable factor, dependent upon many things. In treatment, some of the teeth are used as anchorage; some are to be moved. Those to be moved reach the desired positions in varying periods of time. As soon as any one of them reaches its correct position it should be held there in a stable manner. For the anchor teeth and for the teeth that have reached their destinations, stability is now the quality most desired in an appliance. For those that are still moving or to be moved, elasticity in the appliance is the quality to be wished for. Therefore, need for these qualities—stability and elasticity—not only vary in different sections of the appliance, but also vary in various stages of treatment.

Having determined that there is need for a high degree of stability in some sections of an appliance and for elasticity in others, and also that it is

desirable to vary the degree of each of these qualities from time to time, let us consider how they are provided in a typical modern orthodontic mechanism such as the edgewise appliance.

In a previous article I called attention to the fact that power stored in an arch wire generally delivers that power through levers of greatly varying lengths.[1] These levers not only act upon the teeth singly, but in multiples, ranging in variety through the gamut of the full three classes of levers.

It is obvious that if force were to be applied evenly to all teeth in the dental arch over a period of time, the cross section of the arch wire would have to vary in size throughout its length. This being impractical, it follows that the arch wire should be of such cross section and strength throughout as would most nearly meet all demands that are made upon it in storing and delivering power and providing at least the minimum requirements of stability. To determine what this cross section might be to meet these demands, let us consider what some of these variations are.

The greatest demand for force from an arch wire is in a lateral direction to create expansion or contraction of the dental arches. When these movements are necessary, it is generally desired to move all the teeth of each lateral half in the same direction simultaneously. The largest and most firmly embedded teeth are the molars. Because of their attachments and their placement in the distal arch, they place a great burden upon the arch wire laterally at its distal levels. In the use of the expansion arch principle, movement of one molar makes use of anchorage in the opposite molar. This anchorage must be transmitted through the entire length of arch that lies between them. This means that power delivery is made at the free ends of extremely long sections of arch wire, much as a man lifts hay at the end of a pitchfork. Thus, force is delivered against tremendous leverage. This power is stored through a long length of arch wire and is therefore fed back evenly over a relatively great distance. It is entirely conceivable that all of this movement desired for a given case might be accomplished by one adjustment of the appliance.

Let us consider now the opposite extreme, for example, rotations. In the use of the edgewise appliance all of the teeth are usually banded. Most rotated teeth are moved into proper positions by a lever which extends to the adjoining tooth upon the side on which the ligature is applied. Power is also stored by the tie, in the arch section between several of the adjoining teeth, the arch wire being distorted first labially then lingually in amounts diminishing to the vanishing point. The primary lever is extremely short, as compared with the long arch sections just considered for molar expansion. Power having been stored in a relatively short section of arch wire, power delivery will be made over a relatively short period of time and distance. To gain much rotation with each adjustment, under these circumstances, a great deal of force must be applied to distort the short section of the arch wire enough to accomplish power delivery over a sufficient distance. For this reason power will be quickly delivered as a short heavy jolt and then cease. Adjustments of this type must, therefore, be repeated many times.

Mesiodistal tipping movements are accomplished by means of two short levers each extending to the next point of attachment of the arch wire. These attachments act as moving fulcrums. Here again power is stored in short sections of arch wire over a relatively short distance and is delivered as short, heavy jolts which continue for only a short time. Torque or buccolabial tipping of teeth is likewise accomplished by equally short, double levers each extending to its next point of attachment.

Anchorage for practically all tooth movement works upon a shifting base and results in the resistance being passed progressively from point to point as tooth movement takes place. To trace accurately the power stored and delivered by an arch wire for individual tooth movements is a very complex undertaking, for the arch is generally serving several masters at the same time, each exacting different labor.

It becomes apparent than that an arch wire of uniform, standard design and size cannot serve with equal efficiency for all of the various purposes that it is called upon to serve. A definite amount of force can be distributed over perhaps an inch of distance to accomplish width in the molar region. That same amount of force will be delivered over a distance so small that the eye can scarcely discern it if stored in the usual short section to accomplish rotations.

It would seem that the minimum size cross section of the arch wire must be determined by the minimum requirement to expand the dental arches laterally and to provide sufficient stability throughout the length of the wire. The maximum cross section should be determined by the requirements of torque, tip, and, particularly, rotation movements. It is quite conceivable that an arch wire of greater cross section than the standard 0.022 by 0.028 might be used to advantage to accomplish lateral width. It is all too apparent that one many times lighter would be of advantage to accomplish other movements. Just as lateral width can now be accomplished in many instances with one adjustment, any tooth movement might be accomplished with one adjustment if the arch wire were to be reduced in size to the point where it became elastic over a sufficient distance. This statement is not only theoretically true, but has been practically proved by all who have used 0.015 inch, 0.018 inch, or even 0.022 inch round steel arch wire in competition with heavier ones.

It is conceivable to me that the edgewise appliance principles may someday be applied by using an arch wire of extremely elastic metal of a diameter which may be only a small fraction of that of the cross section of the present one. This would necessitate the accomplishment and stabilization of lateral molar width by auxiliary means, possibly a supplementary labial or lingual arch so applied as to perform only that purpose.

Subsequent to my redesigning of the 447 edgewise arch bracket to its present form, I did some experimenting in order to determine whether or not an arch slot of a different size than the present one 0.022 inch by 0.028 inch might be indicated. This appeared probable, in view of the apparent trend toward the use of stainless steel as an arch wire material.

The bracket with a slot 0.022 inch by 0.028 inch was designed by Dr. Angle to accommodate a range of precious metal arch wire sizes which most

nearly met the maximum and minimum demands placed upon them. Experience has proved that this size was wisely chosen. The minimum size that will stand the average stress brought to bear upon it in function seems to be 0.022 inch round. Wire in this dimension, however, will not stand the stresses of mastication in all cases. Arch wires of 0.022 inch by 0.028 inch are certainly beyond the maximum size to accomplish rotations most effectively, but it is probably minimum to accomplish molar width to the best advantage.

With the advent of stainless steel, it became apparent that a new and different set of possibilities and limitations came into being. In the hope that these new materials would resist undesirable distortions better than those previously used, we experimented with brackets with slot size 0.018 inch by 0.028 inch, using round and rectangular arch wires of both stainless steel and precious metal, to fit them. Results seemed hopeful and we converted our practice to appliances using these brackets. Records showed that by their use treatment time was reduced approximately two and one-half months per case. After long and sufficient experimentation, we reconverted the practice to the present standard-sized brackets, and now believe that they offer the best possibilities for the most advantageous combinations of the compromises that have always been and always will be necessary when using appliances of the present-day design and materials. It seems to me to be probable that all of the materials that it is possible to use to make appliances as they are made today have been used and thoroughly tried and experimented with. It also seems logical to believe that when improvements come, they will come in change of design, but using some of our present materials.

I want now to give credit to Dr. Clu Carey of Palo Alto, Calif., for suggesting what I believe is a new principle in the design of orthodontic arch wires, and I believe that it is a good one.[2] Multiple round arches have been used successfully to store sufficient power without sacrificing elasticity. To my knowledge, Dr. Carey's principle of using a square arch divided lengthwise into two halves and boxing it in a bracket between parallel walls is new and offers hope of gaining elasticity without correspondingly losing stability, and at the same time maintaining control of tipping and torquing with the appliance. This arch he refers to as "Arch DR 11." It makes use of the simple principle of the leaf-spring such as is used in wagons, buggies, and, in the present day, automobiles.

If an automobile spring were to be made as one solid piece, the spring would bend only fractions of an inch under the usual forces applied to it. The same amount of metal, split into leaves, will bend over many inches when the same or similar forces are applied; thus the leaved spring serves its purpose to absorb shock and deliver it back to the automobile gradually. An automobile spring does not destroy force or shock; it merely distributes the force or shock according to the dictates of time and place.

When a bar is bent, a distortion takes place within the molecules of the metal. This distortion occurs as elongation or stretch on one side of the bar and compression or shortening on the other (Fig. 1). This stretch and com-

pression can be explained on the basis of the law of levers. It is proportionate to the amount of the bend and to the thickness of the bar. In Fig. 1 the bar *B* is one-half the size, in cross section, as the bar *A* and it has the same degree of bend, under stress, from the horizontal. Note that there is one-half as

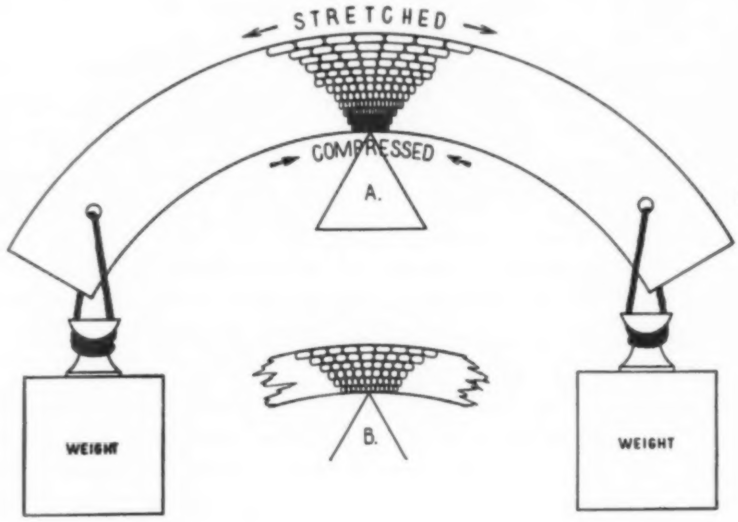


Fig. 1.

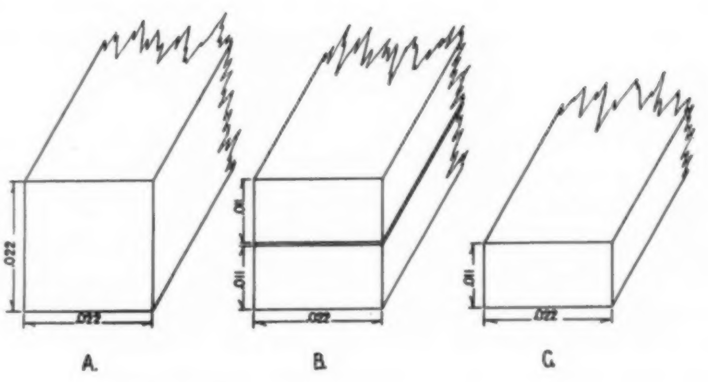


Fig. 2.

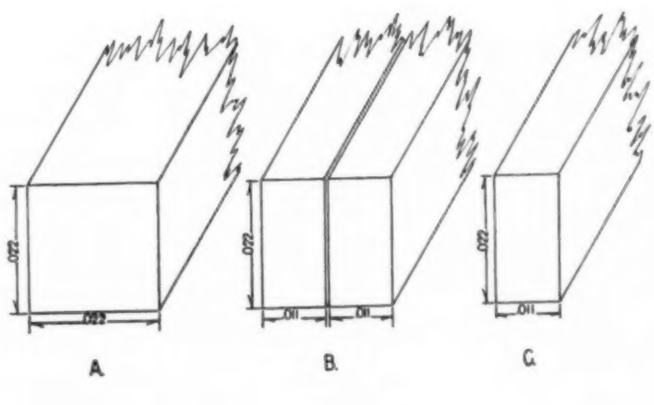


Fig. 3.

much compression and elongation in its sides as shown by the shapes of the molecules. Very obviously the greater the bend the greater the compression or stretch in the sides of the metal. On the other hand, the thicker the bar the greater the compression and elongation of the sides. Theoretically at least, a bar that is one-half the thickness of another of, otherwise, the same dimensions, should bend twice as far to create the same amount of compression and elongation in the opposite sides of the bar.

If a beam (Fig. 2, *A*) is divided equally in the horizontal direction (Fig. 2, *B*), the same mechanical principles would exist in each half. When bent vertically the same distance, there would apparently be one-half as much compression and expansion in the molecules of the metal in each of the halves of the divided beam (Fig. 2, *B*) as there would be in the whole (Fig. 2, *A*). By the same principles it seemed to me that the divided beam would bend twice as far to cause the same amount of distortion in the sides of the metal. It was my belief that, barring friction, the same stored power could be distributed over twice the distance with an arch wire made as is shown in Fig. 2, *B* as it could be in the case of Fig. 2, *A*.

Turn the divided beam over (Fig. 3, *B*) so that it is divided vertically and bent vertically, and a different set of conditions becomes apparent. To be deflected in this direction, the upper and lower portions of the divided beam would compress and elongate according to the same mechanical laws as exist in the original undivided beam (Fig. 3, *A*). In this direction, it is, therefore, more resistant to undesirable distortion and is less elastic. Opposed to my belief that these statements must be true because of the theories I had in mind for them, digital examination and clinical experience indicated that they are not true.

I also believed that a rectangular wire of the same width as a square wire and one-half as high has more than twice the elasticity as has the square one and bends a given distance with much less than one-half the force. It also seemed to me that some of the claims for superiority made for stainless steel as a power-storing material were perhaps influenced by the psychology of the word "steel." In order to test these and other qualities in both steel and precious metal and to determine the effect of sizes and designs of wires for orthodontic purposes, the following experiments were performed.

METHOD

For the sake of ease of description let it be assumed that all wires described are in a horizontal position. For example, reference to a wire being divided horizontally will mean that it consists of two halves, one above the other, each being one-half the thickness of the whole, the two being fitted together against their flat sides. Four-inch lengths of wires were tested by fixing them in a vise by one end and applying weights of various sizes at the opposite ends. Wires were also tested in the Tinius Olsen, Tour-Marshal tester. The stainless steel wires were of the usual quality obtainable from dental supply sources. For precious metal wires, Wilkinson's high-spring orthodontic alloy was used. Precious metal wires were heat-treated at 850° F. for five minutes,

unless otherwise designated. In all cases pressure applied for testing was applied in a vertical direction. When discussing deformation in metals the terms, *proportional limit, elastic limit, yield point,* and *elastic deformation* are all commonly used. For our purposes a consideration of proportional and elastic limits will be dealt with.

DEFINITIONS

The proportional limit of a metal is the point up to which the metal is deformed in direct proportion to the force applied, beyond which deformation increases proportionally.

The elastic limit of a metal is the limit of deformation beyond which the metal will not recover its original shape.

For all practical purposes, the proportional limit and the elastic limit occur at the same degree of bend and will here be considered to be identical. Proportional limit and elastic limit can be read from the Tinius Olsen tester graphs as the point on the graph at which the straight line breaks into a curve (see Fig. 6). On this graph the scale on the left represents the amount of load, expressed in units of force; the scale at the bottom represents the degrees of angular deflection, or bend. As long as the deformation is proportional to the load, the plotting points fall in a straight line. When the proportional limit and the elastic limit of the wire are reached, the deformation in the wire increases porportionately to the load and the points fall to the right of the straight line, along a curve.

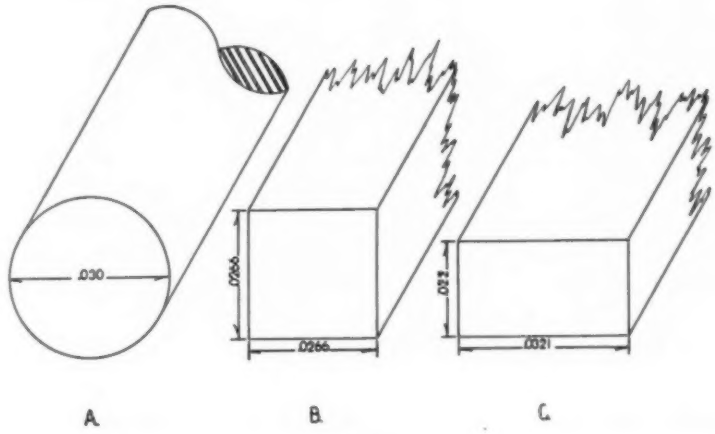


Fig. 4.

EXPERIMENT I

In order to determine by experiment the effect of differing shapes of wires, as are in practical use, three precious metal wires identical except in cross sections, in sizes 0.030 inch round (Fig. 4, *A*), 0.0266 inch by 0.0266 inch square (Fig. 4, *B*), and 0.022 inch by 0.321 inch rectangular (Fig. 4, *C*) were used. These wires were hardened in dry heat at 800° F. for five minutes and were then tested in a Tinius Olsen tester at one-half inch leverage.

It will be noted that when the metal of a round wire is converted into a square wire, the square one has less vertical height than the round one, and when reconverted into a rectangular wire it has still less vertical height through its thin dimension, but, when turned on edge, it has more vertical height than either the round or the square wires. Because of the differences in vertical height, the compression and elongation of the sides of these wires would differ, and the graph (Fig. 5) discloses the differences in stiffness, strength, elasticity, and proportional and elastic limits that might be expected.

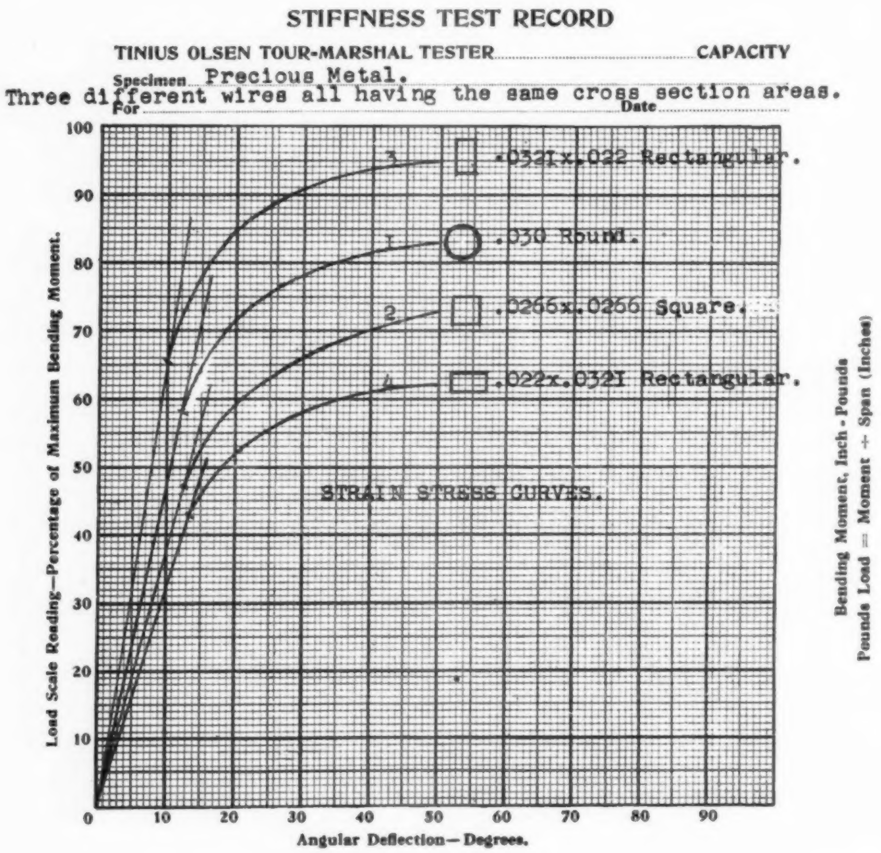


Fig. 5.

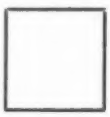
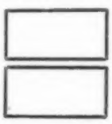
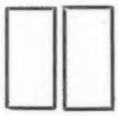
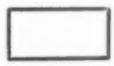
Also, the graph shows that the round wire is stiffer than the square. It took 58 units of pressure to bend the round wire through 12 degrees, whereas in the case of the square wire 57 units of pressure bent it through only 12½ degrees. These results are shown even more clearly in the case of the rectangular wire, bent through its thin dimension. Forty-three units of load bent it 14½ degrees through this dimension, whereas 65 units of load bent it only 10 degrees through its wide dimension. Examination of the graph also discloses that the elastic limits of these wires are, respectively, 10 degrees, 12 degrees, 12½ degrees, and 13 degrees of bend and with a difference of 65, 58, 47, and 43 units of load, in that order. Remembering that these wires are identical in metal content, the

difference in them being merely in their shapes in cross section, the designs of the cross section of orthodontic wires are clearly shown to be important.

EXPERIMENT II

In order to test wires by a method the results of which would be clearly seen and understood, and expressed in terms to which orthodontists are accustomed, the following technique was employed. Four-inch lengths of wire were held horizontally in a vise in front of graph paper (Fig. 6). Very short sections of the ends of the wires were bent up at right angles to prevent the weights from falling off. (The weights of the wires and the friction between them were disregarded because the principles in question could be adequately demonstrated with a sufficient degree of accuracy without taking them into account.) Fig. 6 shows a stainless steel wire 0.022 inch by 0.022 inch and a precious metal wire 0.022 inch by 0.022 inch fixed in a vise with 5 dwt. weights suspended on their opposite ends, as previously described. Table I shows the angular deflection in

TABLE I. STIFFNESS AND ANGULAR DEFLECTION OF STAINLESS STEEL WIRE IN INCHES*

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
					
	0.022 INCH BY 0.022 INCH; BENT VERTICALLY	0.022 INCH BY 0.22 INCH; DIVIDED HORIZONTALLY; BENT VERTICALLY	0.022 INCH BY 0.22 INCH; DIVIDED VERTICALLY; BENT VERTICALLY	0.011 INCH BY 0.022 INCH; EDGEWISE; BENT VERTICALLY	0.011 INCH BY 0.022 INCH; FLAT; BENT VERTICALLY
DWT.	DEFLECTION	DEFLECTION	DEFLECTION	DEFLECTION	DEFLECTION
1	0.25	1.00	0.25	0.55	1.75
2	0.50	1.70	0.50	1.05	2.50
3	0.70	2.20	0.70	1.60	2.85
4	0.90	2.50	1.00	1.90	2.05
5	1.10	2.70	1.15	2.10	2.65
10	1.85	3.00	2.00		

*Tests made with weights suspended at ends of four-inch lengths of straight wire. Stainless steel wire 0.022 inch by 0.022 inch; stainless steel wire 0.011 inch by 0.022 inch.

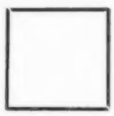
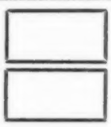
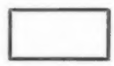
inches that occurs when these and other loads are applied to stainless steel wires of sizes 0.022 inch by 0.022 inch and 0.011 inch by 0.022 inch in various positions and combinations. Column 1 of the chart shows the number of pennyweights of "load applied." Other columns show the amount of deflection, in inches, of wires of various sizes under various loads. Table II is identical with Table I, but shows the angular deflection of *precious metal* wires.

We will first test the stainless steel wire 0.022 inch by 0.022 inch and precious metal wire, 0.022 inch by 0.022 inch. When using 5 dwt. (Fig. 6), the deflection for the steel (wire 1) can be read as 1.1 and for the gold wire (wire 2), the reading is 1.15. These figures and others are shown in Table I, column 2, and Table II, column 2. Within the limits of accuracy of this method of reading, the deflections for the two wires were within 0.05 inch of being identical.

This slight difference means that, for orthodontic purposes, a given amount of force can be distributed over a very slightly greater distance with precious metal wire than with stainless steel wire of the same shape and size.

The tables also show the results of tests with other stainless steel and precious metal wires in other sizes and combinations. It was found that the angular deflections in other sizes of stainless steel and precious metal wires of the same size were relatively similar to those in this first test. Because of this close similarity of the deflection factors of stainless steel and precious metal, we will confine our discussion to a consideration of the differences occurring in sizes and shapes of the *precious metal* wires.

TABLE II. STIFFNESS AND ANGULAR DEFLECTION OF PRECIOUS METAL WIRE IN INCHES*

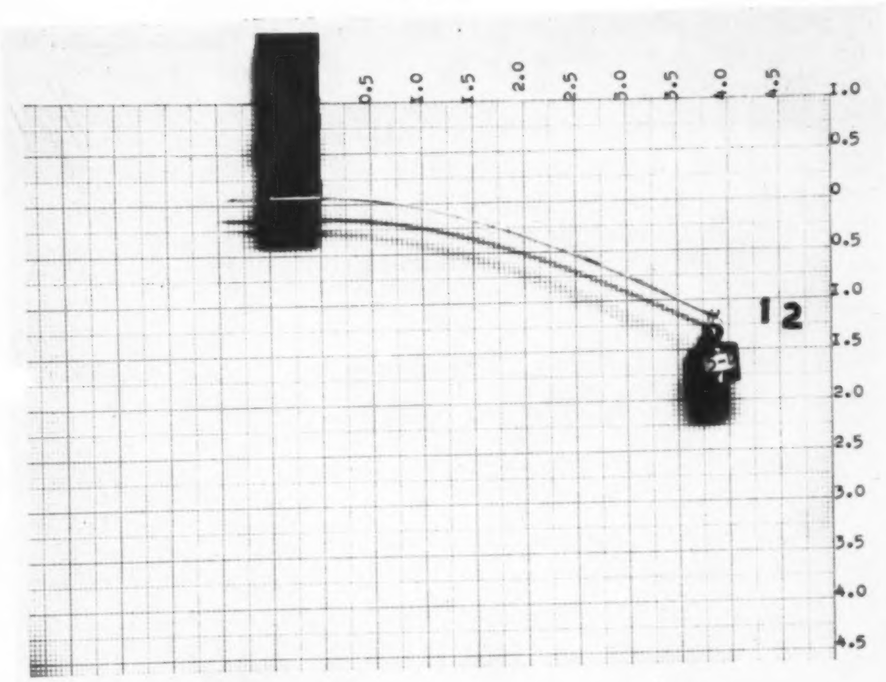
COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
					
	0.022 INCH BY 0.022 INCH; BENT VERTICALLY	0.022 INCH BY 0.022 INCH; DIVIDED HORIZONTALLY; BENT VERTICALLY	0.022 INCH BY 0.022 INCH; DIVIDED VERTICALLY; BENT VERTICALLY	0.11 INCH BY 0.022 INCH; EDGEWISE; BENT VERTICALLY	0.011 INCH BY 0.022 INCH; FLAT; BENT VERTICALLY
DWT.	DEFLECTION	DEFLECTION	DEFLECTION	DEFLECTION	DEFLECTION
1	0.25	1.00	0.25	0.55	1.75
2	0.50	1.75	0.50	1.05	2.55
3	0.75	2.25	0.80	1.50	2.85
4	1.00	2.50	1.00	1.80	3.10
5	1.15	2.70	1.20	2.50	3.85
10	1.95	3.20	2.00		

*Tests made with weights suspended at ends of four-inch lengths of straight wire. Precious metal wire 0.022 inch by 0.022 inch; precious metal wire 0.011 inch by 0.022 inch.

In order to test the angular deflections per unit of weight, of a square wire versus a rectangular wire of the same width, but of half the height (one-half the cross section of the square), a precious metal wire, 0.022 inch by 0.022 inch and one 0.011 inch by 0.022 inch were fixed in a vise (Fig. 7). Here was a great surprise. In the case of the 1 dwt. test, the deflection of the 0.022 inch by 0.022 inch (wire 1) was 0.25 inch. That of the 0.011 inch by 0.022 inch (wire 2) was 1.75 inch. This is a ratio of one to seven. Instead of the thin wire deflecting twice, or possibly four times, that of the thick wire, as was expected, it was deflected seven times as much as the thick one.

As previously stated, it was my belief that if two thin wires were laid flat, one upon the other, to form a square, each thin wire would act independently of the other and the combination of the two would effectively resist twice as much force as one piece alone. I also believed that a square arch wire made up of two equal flat sections laid flat and fitted together on their flat sides would deflect twice as far as a solid square arch wire of the same size. This principle was tested as in Fig. 8, the results of which are shown in Table II, columns 2 and 3. It will be seen that the deflection is not in a ratio of one to two but instead approximately one to four.

Fig. 6.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2.5
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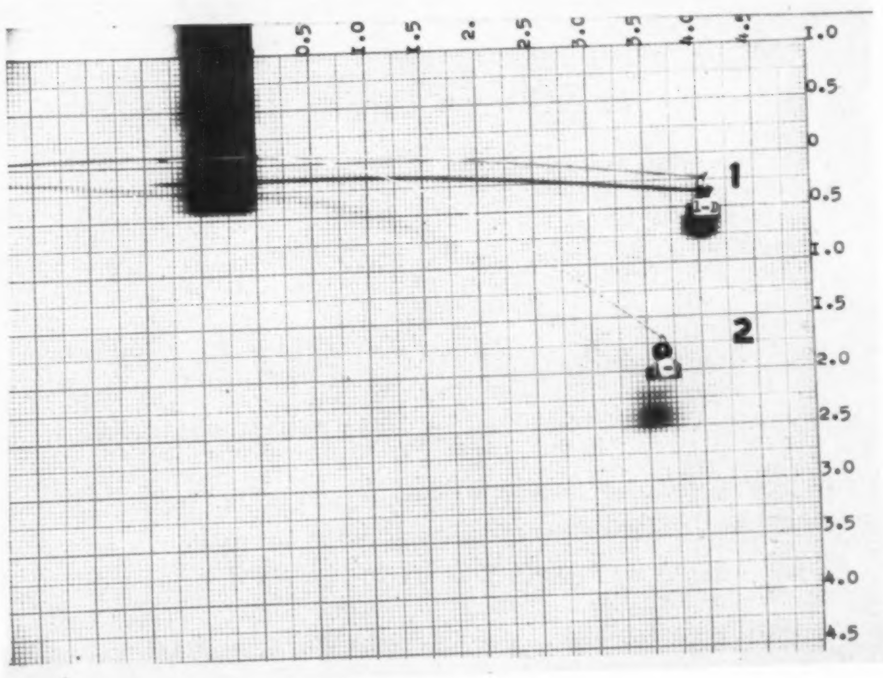
4.5
1
2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1.5
2.0
2.5
3.0
3.5
4.0
4.5
1
2

Fig. 7.

The discrepancies in the findings of these last two tests were studied and it was determined that the law of diminishing leverage comes into play as the weights swing back under the point of attachment. It was recognized that this principle must either be reckoned with, or that tests should be made in another manner. These discrepancies did not explain the unexpected relative increase in deflection of thin wires, as compared with thick ones under the same load, and so an explanation was sought and found in textbooks dealing with the physical qualities of metals.

Timoshenko and McCullough,[3] in their book, give a formula bearing on the subject:

When: y = displacement.
P = load.
E = modulas of elasticity in tension and compression.
I_z = moment of inertia with respect to the z axis.
L = length of lever.
X = distance of load from point of support.

Then: $$y = \frac{P}{EI_z} \frac{LX^2}{2} - \frac{X^3}{6}$$

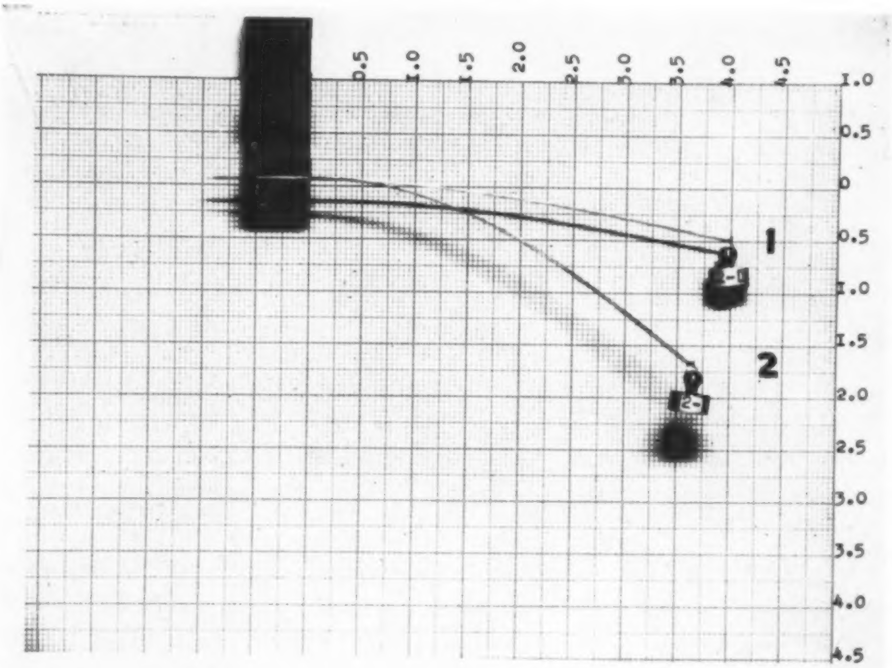
For the purposes of illustration and example such as we are using in our experiment, the load will be placed at the end of the wire; therefore, $X = 1$. The equation for the displacement then becomes $y = \frac{P}{EI_z}\left(\frac{L^3}{3}\right)$. To illustrate the use of this formula, applications will be made to the deflection in two wires of equal length, under a constant load. The wires will differ in that one is square and the other rectangular in cross section.

For a square and a rectangle, the moment of inertia, I_z, can be calculated from the dimensions of the wire with the formula, $I_z = \frac{bh^3}{12}$ where b is the horizontal dimension and h is the vertical dimension. Let D be the sides of the square wire. For a square, then, it can be seen $I_z = \frac{D^4}{12}$. For a square divided horizontally, $I_z = \frac{D^4}{96}$. For a square divided vertically, $I_z = \frac{D^4}{24}$ (Table III).

It can be easily shown by substitution of the above values of I_z in the formula for deflection given above, that the deflection to be expected from the loading of wires of equal length but differing in cross section, one a square and the other a rectangle one-half the width horizontally and the full width vertically, with equal loads, the vertical deflection will be in the ratio of one to two.

A square face such as 0.022 inch by 0.022 inch divided horizontally becomes two rectangular faces each 0.011 inch by 0.022 inch, the 0.011 inch dimension being vertical and the 0.022 inch being horizontal. Each of these rectangles has a deflection factor of eight times the deflection of the square. The deflection of the combination of the two would be one-half of each and would therefore produce a deflection factor of four. (For this and other figures see Table III.)

Fig. 8.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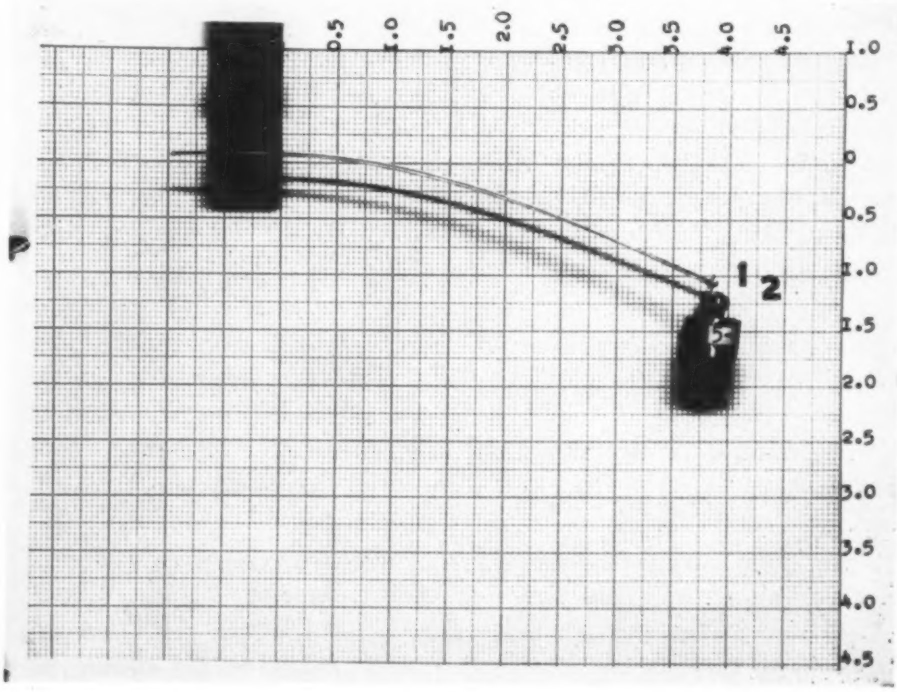
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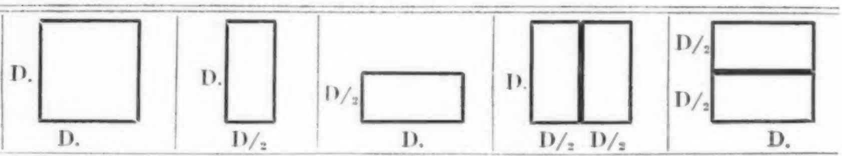
2

Fig. 9.

TABLE III. DEFLECTION RATIOS FOR TYPICAL FIGURES



	D. × D.	D. × D/2	D/2 × D.	D. × D/2, D/2	D/2, D/2 × D.
Moment of inertia I_x	$\frac{D^4}{12}$	$\frac{D^4}{24}$	$\frac{D^4}{96}$	$\frac{D^4}{12}$ $\frac{D^4}{12}$	$\frac{D^4}{96}$ $\frac{D^4}{96}$
Deflection factors	1	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{2}$ $\frac{1}{2}$	$\frac{1}{8}$ $\frac{1}{8}$
Deflection ratios	1	2	8	1	4

It will be seen that if a square wire is divided horizontally into halves, each half should distort equally under the same load. The deflection actually is, not two or four times that of the square as I had expected, but, according to this formula, the distortion would be eight times that of the square, or in the ratio of one to eight.

It is obvious that the strains in metals under tension are not as simply explained as I had thought, but my original tests did give answers similar to those arrived at by this method, and it was concluded that additional tests by the method would be useful.

It was my opinion that a square wire divided vertically should resist force vertically in a manner equal to that of an undivided wire of the same size. To test this premise, precious metal wires 0.022 inch by 0.022 inch and 0.022 inch by 0.022 inch divided vertically (0.011 inch by 0.022 inch double and bent through their 0.022 inch thickness) were mounted and tested. A typical test is shown in Fig. 9, and the readings are given in Table II, columns 2 and 4. It will be seen that the results were as expected and that the principles previously stated in this article do hold true.

Our test shows that an arch wire divided vertically will resist undesirable distortion vertically in an amount equal to that of a square wire. We have previously seen that through the opposite dimension of such a divided wire, the deflection is four times that of a solid square wire and it is eight times as elastic. Therefore, in this direction, a given amount of power can be distributed as force over *four times the distance* as that of a square wire and twice as much force can be distributed through *eight times the distance*.

To test more accurately the wires in question, access to a Tinius Olsen tester was arranged, and tests were made and recorded in Tables IV and V.[3, 4, 5] All wires were tested through sixty degrees of bending using one-half inch leverage. With this machine the proportional limits and the elastic limits are discernible. In both tables the size of the wire and the material of which it is made are shown. In both tables column 1 represents the degree to which the wire is bent, in stages of three degrees. In the other columns, the units of load

applied to the wire are shown. The last line records the set angle in degrees. Set angle is the angle of permanent bend that remains in the wire after it has been bent through sixty degrees and then released.

Examination of these tables shows that very slight discrepancies do exist between the readings shown here and those that could be arrived at by the formulas mentioned. These discrepancies are logical on the basis of the difficulties of bending wires through their flat sides without torquing them, in-

TABLE IV. STIFFNESS AND ANGULAR DEFLECTIONS IN STAINLESS STEEL AND PRECIOUS METAL WIRE IN DEGREES*

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
	STAINLESS STEEL		PRECIOUS METAL	
DEGREES BENT	0.11 INCH BY 0.22 INCH BENT THROUGH 0.011 INCH THICKNESS	0.011 INCH BY 0.022 INCH BENT THROUGH 0.022 INCH THICKNESS	0.011 INCH BY 0.022 INCH BENT THROUGH 0.011 INCH THICKNESS	0.011 INCH BY 0.022 INCH BENT THROUGH 0.022 INCH THICKNESS
DEGREES	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD
0	0	0	0	0
3	2	8	1.5	5
6	4	15	3	10
9	6	22	4.5	16
12	8	28	6	22
15	10.5	35	8	27
18	12.5	42	9.5	29
21	14	47	11	31
24	16	51	12	32
27	18	56	13.5	33
30	19	58	14	34
40	24	63	15	36
50	26	63.5	16	37
60	31	64	17	37.5
Set angle in degrees	24	38	30	43

*Tests were made with Tinius Olsen Tour-Marshal tester sample bent through sixty degrees. Stainless steel wire 0.011 inch by 0.022 inch; precious metal wire 0.011 inch by 0.022 inch.

consistency of hardness and temper and the lack of absolute accuracy in their sizes. This is particularly true of stainless steel, for if I learned nothing else from these tests I did learn that stainless steel is extremely difficult to obtain in accurate sizes and in uniformly consistent degrees of hardness, stiffness, and elasticity. Great variations in these qualities were found throughout the length of the pieces examined. A much higher degree of accuracy was found in precious metal.

At this point I would like to make the following observations derived from study of these charts. Under a given load the following facts are indicated:

1. Precious metal wires bend more than stainless steel wires of the same size under the same load.

TABLE V. STIFFNESS AND ANGULAR DEFLECTIONS IN STAINLESS STEEL AND PRECIOUS METAL WIRE IN DEGREES*

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7
	STAINLESS STEEL			PRECIOUS METAL		
	0.022 INCH BY 0.022 INCH BENT VERTICALLY	0.022 INCH BY 0.022 INCH DIVIDED VERTICALLY; BENT VERTICALLY	0.022 INCH BY 0.022 INCH DIVIDED HORIZONTALLY; VERTICALLY	0.022 INCH BY 0.022 INCH BENT VERTICALLY	0.022 INCH BY 0.022 INCH DIVIDED VERTICALLY; BENT VERTICALLY	0.022 INCH BY 0.022 INCH DIVIDED HORIZONTALLY; BENT VERTICALLY
DEGREES	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD	APPLIED LOAD
0	0	0	0	0	0	0
3	16	13	4	11	12	3
6	32	26	8	24	24	6
9	48	39	12	35	36	9
12	60	52	16	45	46	12.5
15	70	63	20	51	54	16
18	80	74	24	55	59	19
21	85	83	28	58	62	21
24	90	90	31	60	64	24
27	92	95	35	61	65	26
30	93	105	38	62.5	66	28
40	94		46.5	65	70	31
50	95		52	68	72	33
60	96		54	70	74	34
Set angle in degrees	40	36	23	43	42	30

*Tests were made with Tinius Olsen Tour-Marshal tester sample bent through sixty degrees. Stainless steel wire 0.022 inch by 0.022 inch; precious metal wire 0.022 inch by 0.022 inch; stainless steel wire 0.011 inch by 0.022 inch double (two pieces together to make 0.022 inch by 0.022 inch); precious metal wire 0.011 by 0.022 inch double (two pieces together to make 0.022 inch by 0.022 inch).

2. Square wires divided vertically and bent vertically manifest the same characteristics as undivided square wires of the same size.

3. Square wires divided horizontally and bent horizontally deflect four times as much as undivided square wires of the same size.

4. Rectangular wires of the same width as square wires and one-half their height deflect through their thin sides eight times as much as does a square wire.

5. Rectangular wires, the width and height of which are as two to one, will bend four times as far through their thin sides as they will through their thick sides, under the same load.

Some of these findings came as a surprise to me, but they did explain and justify some of my observations made when using arch wires of this type in clinical practice.

Figs. 10, 11, and 12 are pictures of the stiffness test graphs typical of those from which the figures in Table VI were determined. In addition to giving

these figures, the graphs also show the elastic and proportional limits of the wires tested, in both precious metal and stainless steel.

For example, Fig. 10, showing tests of stainless steel 0.022 inch by 0.022 inch and precious metal 0.022 inch by 0.022 inch, shows that the point of elastic limit was reached in the case of the precious metal at 11 degrees (the point where the straight line breaks into a curve). The stainless steel reached its limit at 10 degrees. These bends were accomplished by 45 units of load for the precious metal and 54 units of load for the steel.

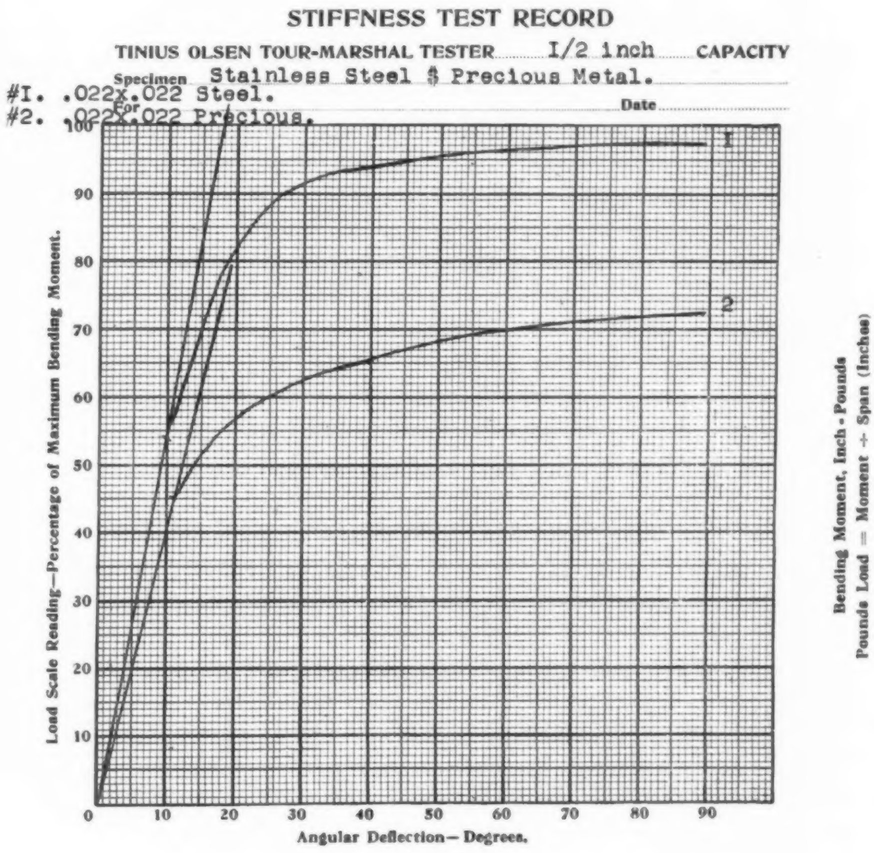


Fig. 10.

Compare these findings, now, to those of Fig. 11 where 0.011 inch by 0.022 inch of both precious metal and stainless metal and stainless steel are tested and the story is very different but proportionately similar. In Fig. 12 where 0.011 inch by 0.022 inch bent through the 0.011 inch thickness is compared to 0.011 inch by 0.022 inch, bent through the 0.022 inch thickness, the elastic limit for the thick dimension is reached at 14 degrees, while through the thin dimension it extends to 30 degrees.

Table VI shows the proportional and elastic limits of both stainless steel and precious metal wires of various shapes, sizes, positions, and combinations.

STIFFNESS TEST RECORD

TINIUS OLSEN TOUR-MARSHAL TESTER I/2 inch CAPACITY

Specimen Stainless Steel & Precious Metal

#I. Steel .0IIx.022 Single Bent thru .0II sides.

#2. Prec. For .0IIx.022 Single Bent thru .0II sides. Date

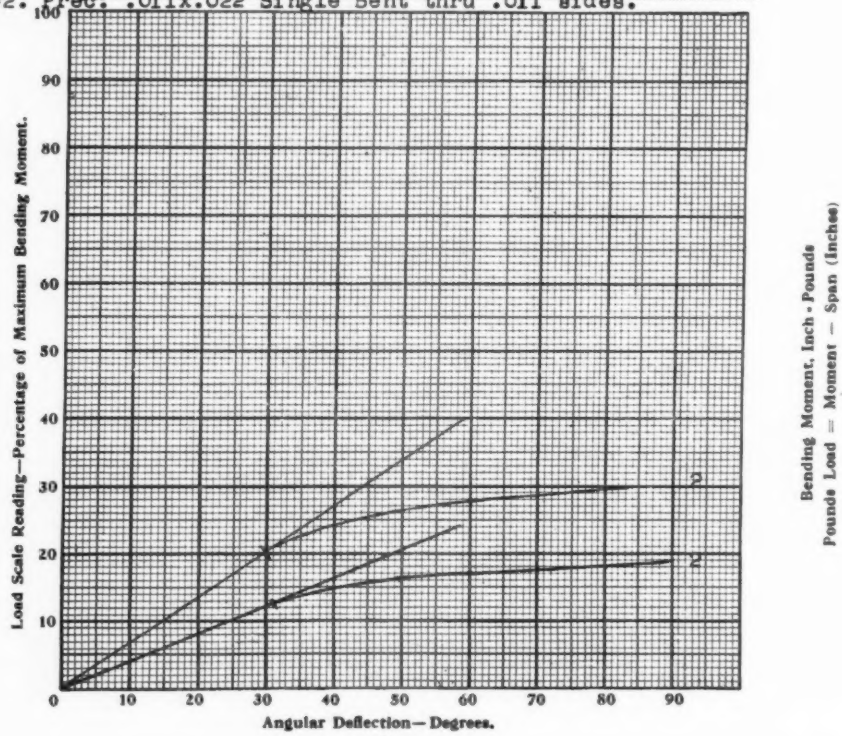


Fig. 11.

STIFFNESS TEST RECORD

TINIUS OLSEN TOUR-MARSHAL TESTER I/2 inch CAPACITY

Specimen Stainless Steel.

#I - Steel .0IIx.022 bent thru .0II sides.

#2 - Steel For .0IIx.022 bent thru .022 sides. Date

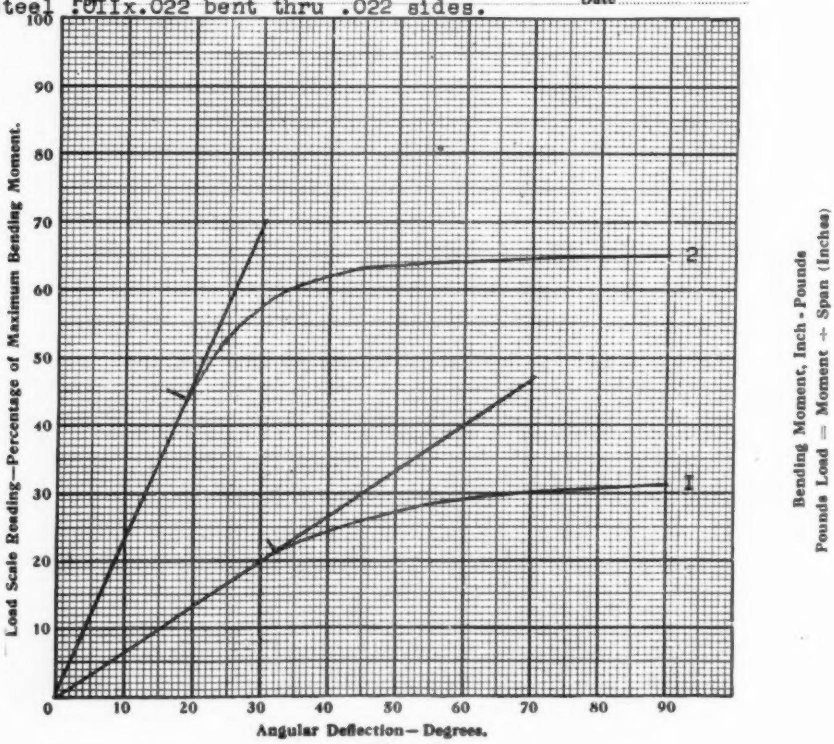


Fig. 12.

TABLE VI. PROPORTIONAL LIMITS AND ELASTIC LIMITS*

WIRES TESTED	PROPORTIONAL LIMITS ELASTIC LIMITS	LOAD SCALE READING (% OF MAXIMUM BENDING MOVEMENT)
	Degrees	*Units*
Stainless steel 0.022 inch by 0.022 inch	10	54
Precious metal 0.022 inch by 0.022 inch	11	39
Stainless steel 0.011 inch by 0.022 inch (Double and bent through 0.011 inch sides)	17	28
Precious metal 0.011 inch by 0.022 inch (Double and bent through 0.011 inch sides)	17.5	19
Stainless steel 0.011 inch by 0.022 inch (Double and bent through 0.022 inch sides)	20	85
Precious metal 0.011 inch by 0.022 inch (Double and bent through 0.022 inch sides)	13	49
Stainless steel 0.011 inch by 0.022 inch (Single and bent through 0.011 inch sides)	32	21
Precious metal 0.011 inch by 0.022 inch (Single and bent through 0.011 inch sides)	32	15
Stainless steel 0.011 inch by 0.022 inch (Single and bent through 0.022 inch sides)	19	49
Precious metal 0.011 inch by 0.022 inch (Single and bent through 0.022 inch sides)	14	24

*Tests made with Tinius Olsen Tour-Marshal tester samples bent through sixty degrees.

These tests would indicate that the distance through which a wire is elastic is directly proportional to its thickness, thin wires being elastic over a greater distance. Both stainless steel and precious metal wires reach their elastic limit at about the same number of degrees of bend. Precious metal deflects to this degree of bend, with less load, than does steel. In other words, the same amount of force can be distributed over a greater distance with precious metal than it can with stainless steel.

Tests conducted, but not shown here, would indicate that both stainless steel and precious metal arches made from straight wires have a higher elastic limit in one direction than they have in another. This can be easily shown by testing and doubtless is the result of the unrelaxed molecular strain that is built up in the metal by bending it into arch form. The strain can be partially reduced in stainless steel, and effectively overcome in precious metal, by heat treatment.

It is apparent that a square arch of either stainless steel or precious metal made up of two lateral halves will excel in elasticity or power-storing ability in one direction, and in stability or resistance to distortion in another. It is also apparent that it can be used as one-half or as two one-halves, either vertically or horizontally, thus varying the amount of the strength, the degree of elasticity, and the resistance to distortion in various portions of its length. I believe that these principles offer great promise for usefulness when employed with the edgewise and other orthodontic brackets. By their use it is possible to vary the degrees of these last-named qualities in various locations in the mouth and thus approach the accomplishment of the ideal conditions which were mentioned earlier in this paper.

CONCLUSIONS

1. Force storage and delivery in orthodontic appliances obviously fall far short of theoretical ideals.

2. Careful consideration brings forth the fact that unless some hitherto unknown principle is made use of, the design of orthodontic appliances must always be aimed to most nearly meet all demands and yet stay within the bounds of the limitations established by the requirements of safety.

3. A considerable amount of effort spent in trying to determine a better slot size for the edgewise bracket has indicated that the present one is ideal as now used, but that should a stiffer, stronger, more elastic metal be developed, of which arch wires can be successfully made and used, then a reduction of bracket slot size would seem to be indicated.

4. A consideration of the physical qualities of stainless steel and precious metal indicates that both have advantages and are useful for the purpose, but favors precious metal as an arch wire material.

5. A square arch wire divided lengthwise, thus consisting of two lateral halves fitted together against their flat sides, offers great promise as an improvement in arch wire design.

I wish to express appreciation to Mr. Charles Teets and to Prof. Reed Brantley for advice, materials, and the use of instruments for this study.

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153 South Lasky Drive.

Resolutions of the Northeastern Society of Orthodontists

JOHN VALENTINE MERSHON

1867-1953

JOHN VALENTINE MERSHON, one of the most beloved benefactors in the specialty of orthodontics, died at his home in Philadelphia, Pa., on Feb. 18, 1953.

John Mershon, the youngest of nine children, was born on July 7, 1867 at Penn's Manor, Pa. His parents were Onias C. and Amanda Valentine Mershon. He attended the local elementary school and the Model School at Trenton, N. J. His dental education was received at the Pennsylvania Dental College (later merged with the University of Pennsylvania), from which he was graduated in 1889 with the degree of Doctor of Dental Surgery. He served as Instructor in Dentistry at his alma mater for a number of years and engaged in the general practice of dentistry in Philadelphia for a period of nineteen years. In 1908 he completed a course of instruction in the Angle School of Orthodontia. Returning to Philadelphia, he limited his practice to orthodontics for the rest of his long professional career.

In 1896, Miss Harriet Lane Worrall, member of an old colonial family of Pennsylvania, was married to Dr. Mershon. Mrs. Mershon continues to reside in Philadelphia.

During his very active career, Dr. Mershon served as president of the American Association of Orthodontists, the Northeastern Society of Orthodontists, the Philadelphia Academy of Stomatology, and was the first president of the Philadelphia Orthodontic Society.

His dental affiliations included the following:

American Dental Association
Pennsylvania State Dental Society
First District Dental Society of Pennsylvania
Fellow of the Dental Society of the State of New York
American Association of Orthodontists
Northeastern Society of Orthodontists
Diplomate of the American Board of Orthodontics
Fellow of the American College of Dentists
International Association for Dental Research
American Association for the Advancement of Science
Southern Society of Orthodontists (Honorary)
Southwestern Society of Orthodontists (Honorary)
Pacific Coast Society of Orthodontists (Honorary)
European Orthodontological Society (Honorary)
Delta Sigma Delta Fraternity

Written by Dr. Leuman M. Waugh at the request of the editor of the American Journal of Orthodontics and the Necrology Committee of the Northeastern Society of Orthodontists. Presented and adopted by the Society in Boston, Mass., Nov. 9, 1953.

He was one of the organizers of, and took an active part in planning, the First International Orthodontic Congress in 1926 and served as an Honorary President.

In addition to his professional interests, Dr. Mershon was long an active member of the Union League Club of Philadelphia where he took particular delight in entertaining his many friends. He was always a genial and generous host.

Perhaps Dr. Mershon's greatest contribution to his profession was in the field of teaching. Many are the orthodontists throughout the world who have received instruction and guidance under his tutelage. From 1916 to 1924, he headed the Department of Orthodontics at the University of Pennsylvania. When the graduate course in orthodontics was established, he was appointed Guest Lecturer in Orthodontics.

He originated and developed the removable lingual arch, combined with a treatment philosophy and technique, that has continued in use for a greater number of years without basic change than has any orthodontic appliance except the plain labial arch.

Dr. Mershon's first recorded paper was presented at the Eighteenth Annual Meeting of the American Association of Orthodontists in 1918, although he had given clinics and demonstrations in his office prior to this time. So urgent was the demand for instruction that he consented to teach privately organized classes in Philadelphia, Nashville, and San Francisco.

The first extension, or so-called refresher, course in orthodontics to be given under university discipline anywhere was directed by Dr. Mershon at Columbia University in 1925. His technical assistants were Joseph D. Eby and John W. Ross. Registration in this class was limited to members of the New York Society of Orthodontists (now the Northeastern Society of Orthodontists). This initial effort was so successful that popular demand led to the giving of many similar courses to members of the American Association of Orthodontists and students from foreign countries in the following years. In all, some 500 (a large majority of the membership of those days) studied the lingual arch therapy under Dr. Mershon. Thus was he a great benefactor to humanity in the field of orthodontics.

Two important facts are worthy of being recorded here. First, Dr. Mershon refused to have the lingual appliance patented for the purpose of accepting royalty. Second, he stolidly insisted on teaching without compensation to keep the tuition low so that it might be easier, especially for the younger orthodontists, to take his courses. The staff of willing assistants who were selected by him also served gratuitously throughout the years.

Dr. Mershon was one of the first clinicians, who early in his practice recognized the fundamental importance of applying biologic principles to the diagnosis and treatment of malocclusion. These he stressed in teaching the practical application of the lingual arch therapy to all of his students and in his contributions to orthodontic literature. Many of us remember some of his simple but potent statements.

"It is the VITAL PROCESSES in a developing child that cause teeth to change their positions and not the appliances.

"You can move teeth to where you THINK they belong; NATURE will place them where they will best adapt themselves to the rest of the organism." In orthodontic publications may be found excellent articles written by John Mershon.

JOHN VALENTINE MERSHON

He has the distinction of having initiated the plan by which dental societies provide short refresher courses for their members. Dr. Mershon organized the first of such courses known in the United States.

Dr. Mershon was the recipient of many honors, some of the most outstanding being:

The William Jarvie Fellowship Medal of the Dental Society of the State of New York, 1930.

The degree of Doctor of Science (Honorary) from the University of Pennsylvania, 1933.

The Albert H. Ketcham Memorial Award of the American Board of Orthodontics, 1937. (Dr. Mershon was the very first recipient of

this, the highest honor within the power of organized orthodontics to bestow.)

For many years, Dr. and Mrs. Mershon enjoyed their beautiful summer home on Peach Blossom Creek at Easton on Maryland's lovely Eastern Shore. Here golf and yachting were his favorite sports. One of his greatest joys was to spend long hours fishing from a cabin cruiser specially built for him. He delighted in having his friends enjoy from his boat the sight of the numerous picturesque "necks" of land to be found there. He and his wife were gracious hosts amidst their gorgeous antiques, most of which have been in Mrs. Mershon's family for generations. Prior to his going to Easton, Dr. Mershon spent many summers at Kennebunk Port, Maine, where golf was his daily diversion. This was continued at Easton's Country Club close to his home.

"Uncle John," as he will always be affectionately known to his students and orthodontic friends, was a genial man with a ready twinkle in his kindly eyes and a humorous story on his smiling lips. He was a sincere and generous man, never self-seeking, always devoid of showmanship. He was happiest when helping others and received his ample reward in the consciousness of having been of service to his colleagues and to his many patients. It can truly be said that he lived by the Golden Rule. His greeting of life may well be expressed by the words of Ella Wheeler Wilcox.

"So many gods, so many creeds,
So many paths that wind and wind;
While just the art of being kind
Is all the sad world needs."

Silver-haired and ruddy-cheeked Dr. Mershon can never be replaced in the affection of his students and friends. His name and contributions to the welfare of humanity will continue to live as long as the specialty of orthodontics.

RESOLUTION: The members of the Northeastern Society of Orthodontists wish to record with profound sorrow the death of their beloved fellow member and benefactor, Dr. John Valentine Mershon, on Feb. 18, 1953.

We desire to express our deepest appreciation of Dr. Mershon's sterling character and of his many contributions to the advancement of our specialty. Through his concept of growth and development, the application of these principles by the therapy which he originated, and his unselfish efforts to teach others, he has done much to raise the standards of orthodontic service. His kind and wise counsel, his ability, and his accomplishments have set an example which we all might well follow.

His loss is keenly felt by this Society and each of us knows a deep sense of personal grief as we realize that the pleasant association of so many years is ended. He will live on in the loving memory of all who knew him well; his name will be immortal in the Hall of Fame of Orthodontics.

To his wife, we extend our deepest sympathy. May she receive consolation in the knowledge that John Mershon was loved and revered by so many who sincerely share her loss.

BE IT RESOLVED, That this resolution be spread upon the minutes and that a copy be sent to Mrs. John V. Mershon.

Department of Orthodontic Abstracts and Reviews

Edited by

DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City

A Metallographic Study of the Bond Between Stainless Steel and Silver Solder: By R. J. Henns, D.D.S., M.S.D., Northwestern University, Chicago, Ill.

SUMMARY

This research was concerned with the following: (1) A metallographic study of the bond existing in soldered joints of 18-8 stainless steel orthodontic wires joined with certain commercial silver solders, one experimental silver solder, and one gold solder. (2) A study of the tensile strengths of butt joints prepared by using each of the solders with their respective fluxes to join 18-8 stainless steel orthodontic wires. (3) A study of the effect on joint strengths when different fluxes were employed with a certain solder.

1. There was definite metallographic evidence that interalloying occurred between seven different solder-flux combinations and the base metal wires. In four of the remaining different solder-flux combinations, interalloying was questionable. However, there was no evidence to indicate that interalloying did not occur in these four solder-flux combinations. There was lack of metallographic evidence to interpret whether or not interalloying occurred in the remaining solder-flux combinations.

2. There was metallographic evidence of grain penetration by twelve different solder-flux combinations. Of the remaining two solder-flux combinations, one solder-flux combination presented no metallographic evidence because the etchant did not attack the solder. The other solder-flux combination presented no metallographic evidence, as there was no photomicrograph of magnification ×800 to be interpreted.

3. Of the total number of voids present in the metallographic joint specimens of the different solder-flux combinations, more than two-thirds of the voids were present in the solders near the interfaces.

4. Nine different solder-flux combinations presented joints with strengths greater than the maximum of 70,000 pounds per square inch generally ascribed to the silver solders used in this research. Six of these nine different solder-flux combinations presented joints with strengths of greater than 95,000 pounds per square inch. The remaining three solder-flux combinations gave joints with strengths less than 5,000 pounds per square inch lower than the maximum strength of 70,000 pounds per square inch generally ascribed to the silver solders. The strengths of these three respective solders more than likely were less than the maximum strength value generally ascribed to the silver solders used in this research.

5. All of the joints fractured in the solder.

6. The same solder used with two different fluxes caused a decrease from the joint strength's value obtained when the same solder was used with its respective flux.

A Cephalometric Radiographic Study of the Change in Relation of Mandible to Maxilla in Orthodontic Treatment: By S. D. Carlson, D.D.S., M.S.D., Northwestern University, Chicago, Ill.

The purpose of this study was to determine the change, if any, of the anteroposterior relation of mandible to maxilla in orthodontic treatment of Class II, Division 1, malocclusion.

The material used in this investigation consisted of 124 lateral cephalometric radiographs made on individuals possessing Class II, Division 1, malocclusion.

The individuals making up this group received their initial orthodontic treatment between the ages of 9 and 13 years, at which time lateral cephalometric radiographs were made. Lateral cephalometric radiographs also were made when these cases were completed between the ages of 12 and 17. These individuals consisted of 32 boys and 30 girls.

The sixty-two cases were divided into two groups, as determined by their mandibular path of closure. One group contains those cases with an upward and forward path of closure, and the other group those cases with an upward and backward path of closure.

SUMMARY

1. No significant change occurs in the anteroposterior relation of the mandible and maxilla in Class II, Division 1, malocclusion cases that show normal paths of closure before orthodontic treatment.

2. A significant decrease in the difference between the angles SNa-SNb occurs in those cases exhibiting upward and backward paths of closure.

3. The downward and forward growth patterns of the mandible and maxilla are equal in magnitude, when referring to the 9- to 14-year age group. Therefore, the downward and forward growth pattern of the mandible should not be relied upon as a factor that normally reduces the apical base difference.

4. The apical base difference may be increased during orthodontic treatment, depending on the differential or disharmonious growth patterns of the mandible and maxilla.

5. A significant change occurs in the alveolar processes during orthodontic treatment.

A Radiographic Cephalometric Study of the Labiolingual Axial Inclination of the Central Incisors in Relation to the Mandible and Maxilla of Excellent Dentitions: By J. E. Williams, D.D.S., M.S.D., Northwestern University, Chicago, Ill.

The method used in this study was radiographic. Lateral radiographs were obtained by positioning the subject's head with the Broadbent-Bolton cephalometer.

Fifty-seven white individuals, thirty-three girls and twenty-four boys, with clinically determined excellent dentitions varying in age from 8 to 15 years were used in this study.

SUMMARY

1. In the excellent occluding dentitions of this study the angular measurements of S-N-a and S-N-b had a position correlation with one another.

2. The angular measurement of Ia—NS (the angle formed by the line through incisal tip of maxillary central and point a with the NS plane), I'a—NS (the angle formed by the line through the occlusal contact point of

maxillary and mandibular central incisors and point a with the NS plane), and *1*—NS proved to be substantially related to the anteroposterior position of the maxilla and mandible.

3. The axial inclinations of the maxillary and mandibular central incisors are more related to the anteroposterior position of the maxilla than to that of the mandible.

4. The anthropometric points used to construct the angular measurements of S-N-a and S-N-b were the most variable in repeating observations (of the points used in this study). The variation, however, was not sufficient to alter diagnostic interpretation of relation of mandible to maxilla.

5. Of the anthropometric points used in this study the ones forming the angular measurement *1*—NS were the least variable in repetitive observations.

6. The angular measurements of Ia—NS and I'a—NS are more expressive in terms of axial inclination of maxillary central incisor teeth than *1*—NS.

7. Further investigation in larger and other classified groups of dentitions must be completed before more positive conclusions can be made.

A Cephalometric Radiographic Method of Classification of the Facial Structures in the Sagittal Plane: By Robert W. Donovan, D.D.S., M.S.D., Department of Orthodontics, Northwestern University Dental School, Chicago, Ill.

There are many systems of classification of facial structures, and, depending upon the problem at hand, most serve a very useful purpose. The artist was probably the first to classify faces, with anatomy and anthropology following closely. Orthodontics, being a fairly recent science and really a combination of art and science, naturally borrowed many of the systems and nomenclature used in art, anatomy, and anthropology.

The present study is not an attempt to classify faces according to esthetic values, genetic factors, or racial characteristics, but is an attempt to classify the face in a manner that might have a direct use in orthodontic treatment and prognosis. Of all of the factors contributing to orthodontic treatment success, the anteroposterior relation of maxillae to mandible and the axial inclinations of the incisors are probably the most important, although by no means the only important factors.

The cephalometric radiograph offers an accurate and simple means of evaluating these two factors. On the cephalometric tracing the S (sella turcica) N (nasion) line is drawn, and point "a" (maxillary apical base) and point "b" (mandibular apical base) are located. Angle SNa is used as an indication of the anteroposterior divergence of the orthodontic treatment area and the angle ab-SN points out the relation of the maxillary and mandibular apical bases. According to the location of these angle values on a certain chart, the treatment prognosis is made easier, and, due to certain correlations between incisor axial inclination and the two angles, the stable position of incisors is more accurately determined.

The value of such a classification lies not in the facial type or form that is seen with the eye when looking at the patient, but in the evaluation of the area that is influenced by orthodontic treatment and that determines the stable and esthetic success of orthodontic manipulation.

News and Notes

The Palmer House in Chicago, where the American Association of Orthodontists will hold its next annual meeting, May 16 through May 20, 1954.

Northeastern Society of Orthodontists

The Northeastern Society of Orthodontists held its annual meeting Nov. 9 and 10, 1953, at Hotel Somerset, Boston, Mass. The program follows.

SUNDAY, NOVEMBER 8

Squibs from a Yankee Scrapbook, Alton H. Blackington.

MONDAY MORNING, NOVEMBER 9

A Technique of Surgical Orthodontia. Daniel J. Holland, Brookline, Mass.

Treatment Problems, Their Origin and Elimination. Robert H. W. Strang.

Resolutions of the Northeastern Society of Orthodontists, honoring John Valentine Mershon. Presented by Leuman M. Waugh.

Late Growth Changes of the Human Face. Allan G. Brodie.

MONDAY AFTERNOON, NOVEMBER 9

The Newburgh-Kingston Caries Fluorine Study. VI. Correlation of Ingested Water Fluorides to Dentofacial Development: A Preliminary Report. David B. Ast.

The Role of Teeth in Man's Becoming Human. Earnest A. Hooton.

Office Management of the Orthodontic Practice. Philip E. Adams, Boston, Mass.

TUESDAY MORNING, NOVEMBER 10

Timing in Orthodontic Treatment. Allan G. Brodie.

Some Criteria in the Diagnosis and Treatment Pertinent to the Extraction of Teeth in Orthodontics. Herbert I. Margolis.

Webster.

Masticatory Function of Orthodontic Patients. R. S. Manly, Boston, Mass.

Pacific Coast Society of Orthodontists

The Pacific Coast Society of Orthodontists, Southern Section, met Friday, Sept. 11, 1953, at 275 North Halstead Ave., Pasadena, Calif. The program follows:

Progressive Clinic:

Treatment Technique in Class II, Division 1 Discrepancy Cases as Used by the Arizona Study Group.

Members participating:
Richard Moffat, Phoenix, Ariz.
Melvin Saxman, Phoenix, Ariz.
Robert Payne, Phoenix, Ariz.
Robert Felix, Tucson, Ariz.
William Tweed, Tucson, Ariz.
Jerry Hiesser, Safford, Ariz.
William Cage, Phoenix, Ariz.
Jess Conant, Mesa, Ariz.
Homer Garson, Los Angeles, Calif.

Dental Sounds and Their Application to Dental Anomalies. John S. Rathbone, D.D.S. (Dr. Rathbone and Dr. John Snidecor, Professor of the Speech Department at the University of California at Santa Barbara have made extensive studies and have devised practical tests enabling the orthodontist to detect and diagnose specific speech defects.)

Next Meeting: Dec. 11, 1953.

PROGRAM: The Pacific Northwest Study Group will be our guests; Dr. Arnold Stoller, President of the Pacific Coast Society of Orthodontists, will serve as chairman.

Rocky Mountain Society of Orthodontists

The Fall Meeting of the Rocky Mountain Society of Orthodontists was held Nov. 2 and 3, 1953, at Denver, Colo. The program follows:

DR. SPENCER ATKINSON—"Suggestions Concerning Diagnosis, Treatment and Retention of Orthodontic Cases"

LUNCHEON—Denver Press Club

DR. ERNEST T. KLEIN—"Balancing Occlusion in Treated Orthodontic Cases"

DR. WM. E. HINES, M.D.—"Endocrinological Aspects of Orthodontics"

PANEL DISCUSSION

MEMBERS OF PANEL:

Dr. Spencer Atkinson
Dr. William Hines
Dr. Henry Hoffman
Dr. Leonard Walsh
Dr. Oliver Devitt, Moderator

Southwestern Society of Orthodontists

The Thirty-third annual session of the Southwestern Society of Orthodontists was held Nov. 1 to 4, 1953, at the Marion Hotel in Little Rock, Ark.

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PROGRAM RÉSUMÉ

DR. ANDREW F. JACKSON

"Orthodontic Perspective"

A broad comprehensive consideration of the basic nature of orthodontics as an all-inclusive anatomic, physiologic, and psychologic problem.

In orthodontics there fortunately are a few simple logical *principles of treatment* of universal application which are in harmony with nature's basic laws, which can be applied to each individual case, and in which a wide variety of appliances find their logical places of greatest usefulness.

This basic idea will be fully amplified and demonstrated by presenting a large and varied number of case reports showing a wide variety of both fixed and removable appliances.

CARL ZEISSE, D.D.S.

"The Camera in Daily Orthodontic Practice"

PART 1. (a) Historical sketch in honor of those who have contributed so generously toward the simplification and standardization of photography in orthodontics.

(b) Photographic Terminology. The purpose is not to confuse you with technical photographic definitions but to givę you only the essential and practical facts that you will need to know about cameras, lenses, and Kodak Porta lenses.

(c) Intraoral Photography (close-up pictures of the mouth). A description of the clinical camera unit in use at the University of Pennsylvania Dental School, Department of Orthodontics. Supplementary lense assembly, focal frame, exposure guide. Versatility has been sacrificed for speed and simplicity.

Clinic to supplement paper

PART 2. (a) Full-Face Photography (faraway pictures of the face). Description of camera support.

(b) Its Application to Cephalometrics. Standardization of results.

(c) The Clinical Camera of the Future. Stroboscopic electronic flash units. The Mighty Midget 11 with circular flash tube. The Bolsey Techno-Medical Unit. The Knebel Clinical Camera. Photography is going through a period of transition. Scientific Program General Clinics to supplement paper.

WM. B. STEVENSON, JR., D.D.S.

Colored movie—"Removable Appliance—Its Construction and Use."

HOWARD H. DUKES, D.D.S., M.S.D.

Case Report—Treatment of Impacted Canines.

GENERAL CLINICS

ARTHUR BOSTICK, D.D.S., CHAIRMAN

TUESDAY, NOV. 3, 3:30 P.M.

1. Wm. B. Stevenson, Jr., "Removable Appliances."
2. J. Byron Smith, "Space Closing Methods."
3. Louis S. Winston, "McCoy Open Tube Appliances."
4. Wells Stephens, "A Simple Torque Indicator for Use With Edgewise Appliances."
5. Drs. Alstadt and Smith, "Cleft Palate Orthodontics." Showing a few cases illustrating cooperative efforts between Orthodontics and Cleft Palate Surgery.
6. Harold S. Born, "Photographic Aids." Reproducing color transparencies to Black and White negatives. Effective Strobe lighting, intra-oral and portraits. Advantages of telephoto lens for portraits.
7. Dan C. Peavy, "Practical Clinical Photography." A simple apparatus you can make economically and use effectively.
8. Curtis W. Williams, "Results Shown in Posterior Occlusion Cases by Wearing Intermaxillary Rubber Bands at Night Only."
9. Leo A. Rogers, "To be Announced."
10. Arthur Bostick, "Removable Appliance Using Elastics to Supply Force."
11. Dr. J. T. Reese, "The High Labial Arch—Some Modern Usage." In selected case this arch has great value in esthetics and cleanliness.

European Orthodontic Society

The next meeting of the European Orthodontic Society will be held at the Grand Hotel in Eastbourne, England, July 1 to 6, 1954.

U. S. Department of Health, Education, and Welfare

''Accidents kill and cripple more of our children than all the infectious diseases of childhood put together,'' according to a report on childhood mortality just released by the Children's Bureau, Department of Health, Education, and Welfare, Dr. Martha M. Eliot, Bureau Chief, announced today. The report is compiled from figures gathered by the Public Health Service's National Office of Vital Statistics in the same Department.

''If parents understood the accident problem and were as concerned about it as they are about polio and other contagious diseases, the toll of childhood death and disability could be cut sharply,'' the report states.

The death rate from accidents among children of ages 1-19 was cut only 16% during the period from 1940-1949 while the rate for all other causes of death among children of these ages was slashed 46%.

Data are charted in detail for the year 1949. There is reason to believe that conditions have not improved substantially since then.

Here are some of the findings of the report:

Children under one year of age died from accidents of all types at a rate of 72.1 per 100,000. Home accidents of various kinds accounted for infant deaths at a rate of 43 per 100,000. Fires, explosions, and burns set a rate of 9.8 per 100,000, and motor vehicles, 6.5. The largest single cause of accidental death in infancy was inhalation or ingestion of objects, with a rate of 28.5. That cause, the report points out, is to be distinguished from ''accidental mechanical suffocation,'' which recent studies show are neither accidents nor due to ''mechanical suffocation.''

Children aged 1-4 years died from accidents at a rate of 37.8 per 100,000. Of this total the rate from motor vehicles was 11.6; from fires, explosions and burns, 9.4; and from drowning, 5.5.

Between the ages of 5 and 9, the total accident rate was 22.3 per 100,000. Largest rate in this group was from motor vehicles, 9.6.

Between the ages of 10 and 14, with a total rate of 22.7, the major killer again was motor vehicles, with a rate of 7.8. Second major cause of accidental death was drowning with a rate of 5.3.

Between the ages of 15 and 19, the total rate was 47.2. Motor vehicles here take their heaviest toll with a rate of 27. Drowning ranked next with a rate of 6.2.

"Accident prevention means setting up and maintaining precautionary measures," the report states. "The measures that could reduce accidents are known to family physicians, health officers, teachers and safety experts. All these people are ready and anxious to help. But they can do little until parents are well enough informed to see that the needed precautions are set up and continuiously maintained in the home, school, and other places where children are exposed to accidents."

Denver Summer Meeting for the Advancement of Orthodontic Practice and Research, Inc.

Participants in the Sixteenth Annual Denver Seminar which was held in Denver, Colo., Aug. 2 to 7, 1953.

First Row: Drs. Hugh Sims, Brandhorst, O'Donnell, H. C. Pollock, Krogman, MacEwan, McDermott, and Klein.

Second Row: Drs. Thompson, Reynolds, Mayeau, H. Carlyle Pollock, Jr., Guerrero, Giblin, Muller, and Pugh.

Third Row: Drs. Yost, Humphrey, Brusse, Burson, Winston, Weesner, Bay, Husted, and Stuller.

Fourth Row: Drs. Bowlin, Holland, Williams, Voight, Thurmond, Byrne, Skaife, Hice, Fred Sims, and Vanda.

Fifth Row: Drs. Harshman, Stevenson, Carman, Norris, Bailey, Ewan, Benton, Callan, Johnson, and Langenfeld.

Orthodontist Gets Sabin Award for Research

Dr. Fred S. McKay of Colorado Springs, Colo., one of the pioneer orthodontists of America, was presented with the Dr. Florence Sabin Colorado Public Health award in recognition of his research in fluorosis. Dr. McKay, the fifth dentist so honored, received the award at a Public Health Service luncheon. Dr. Henry Huffman of Denver presented the award, which is usually given to a layman or medical man outside the Public Health Service for outstanding work in his field.

Through investigative work begun in 1908 when he noticed the prevalence of mottled enamel in the school children of Colorado Springs, Dr. McKay discovered that mottled teeth were caused by fluoridation and that tooth decay in children could be curbed by fluorine in proper amount in drinking water. These studies and findings led to the practice of fluoridating domestic water supplies to prevent dental decay.

Dr. McKay early in this century practiced orthodontics in St. Louis, Mo., and later in Colorado Springs, Colo., after which he moved to New York City, where he practiced periodontia for many years.

University of Tennessee

The University of Tennessee College of Dentistry will offer a course in orthodontics leading to a Master of Science degree, beginning Jan. 1, 1954.

Further information may be obtained from Dr. James T. Ginn, Dean of the College of Dentistry, 847 Monroe, Memphis 3, Tenn.

Notes of Interest

Thorwald Eros, Jr., D.D.S., M.D.S., announces the opening of his office at 302 Medical Arts Bldg., Atlanta, Ga., practice limited to orthodontics.

Dr. Herbert Hoffman, orthodontist, announces the removal of his offices to 87-27 169th St., Jamaica 32, N. Y.

Howard H. Jan, D.D.S., announces the opening of new offices at 1500 Washington Ave., San Leandro, Calif., and the removal of his Oakland offices to 3451 Piedmont Ave., Oakland, Calif., practice limited to orthodontics.

Dr. O. Josell announces the opening of an additional office at 2005 Ocean Ave., between Kings Highway and Avenue "O," Brooklyn 30, N. Y., practice limited to orthodontics. Dr. Josell also has an office at One Hanson Place, Brooklyn 17, N. Y.

Arnold Leeds, D.D.S., announces the opening of his offices at 76 Washington Ave., Garden City, L. I., N. Y., practice limited to orthodontics.

Dr. Cecil G. Muller announces the relocation of his office to Dodge at 35th Ave., Omaha, Neb., practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES

The AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

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